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Photographed by Barnum Brown in 1915, at the time of its discovery and excavation. It is now on exhibition in the American Museum, with giant fossil dinosaurs of the same Cretaceous formation

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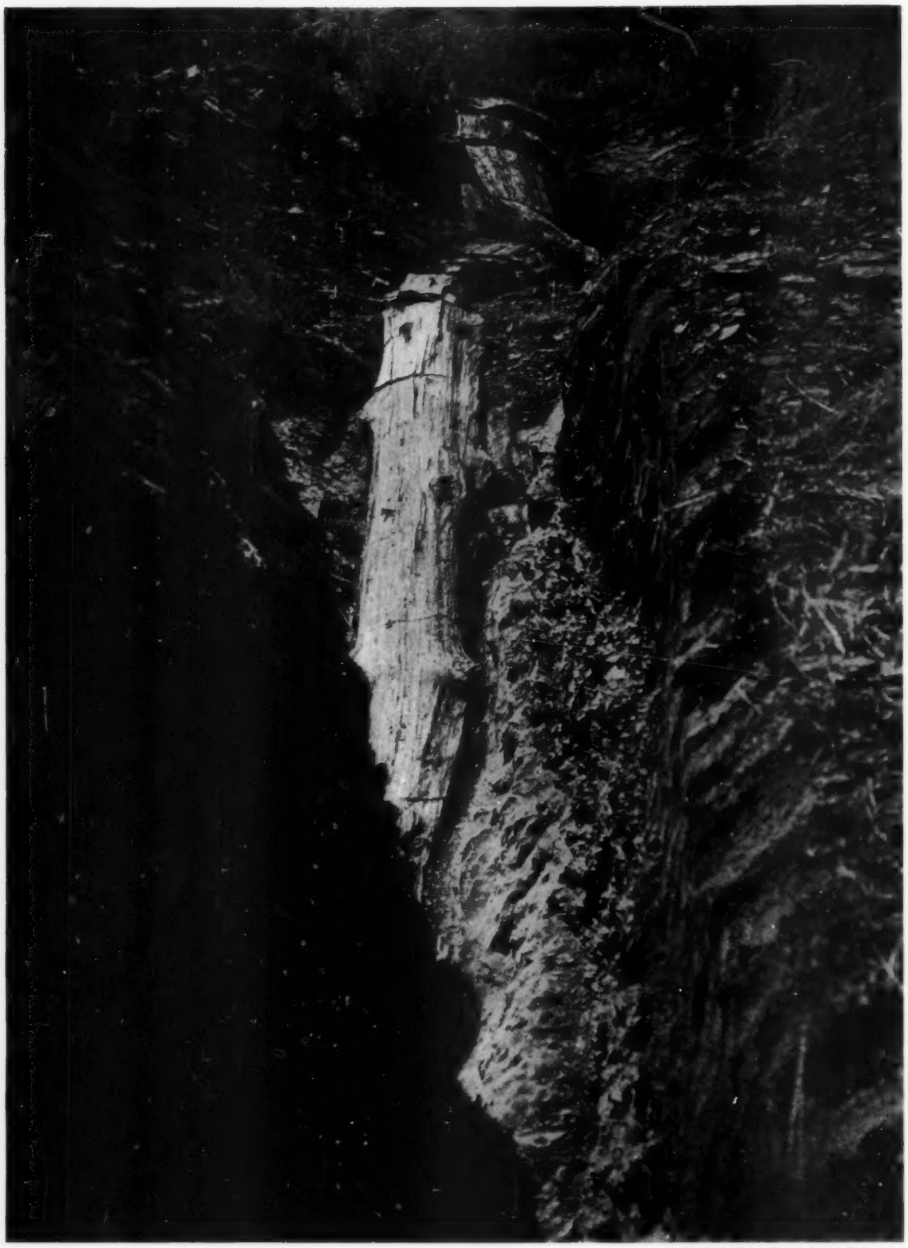

Photo by Barnum Brown

FOSSIL TREE FROM RED DEER RIVER, ALBERTA

This petrified tree trunk, now on exhibition in the dinosaur hall of the American Museum, is forty-five feet long. It is in a fine state of preservation. Many fossilized trees, chiefly cone-bearers, are found associated with dinosaur skeletons on the Red Deer River. They are carbonized and jet black. When found they are surrounded with a thin layer of lignite, which soon disintegrates under exposure, while the central silicified stem bleaches to a reddish buff color

—See note regarding its excavation, page 78

THE AMERICAN MUSEUM JOURNAL

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The "Ostrich" Dinosaur and the "Tyrant" Dinosaur

By HENRY FAIRFIELD OSBORN

This article illustrates some of the methods as well as the "perils" of the restoration of extinct animals from their more or less complete skeletons. A restoration presents the author's theory of the habits of the animal, how it moved, how it fed, how it attacked its prey or escaped from enemies, also the environment in which it lived. In the present instance a dinosaur which was restored and named by the author as an habitual "bird robber" has proved through our discovery of one of its descendants to have followed a less destructive calling. This descendant is known as the "ostrich dinosaur," in relation to a theory of its habits which may in turn prove untenable.—THE AUTHOR.

ONE of the American Museum expeditions of 1902 was hunting dinosaurs in the great geological deposit known as the "Bone-Cabin Quarry" in central Wyoming, not far north of the old line of the Union Pacific Railway. Among the remains of hundreds of skeletons of large forms which we found crowded into this quarry, we discovered one very small,

***Ornitholestes*, the "Bird Robber," and *Archæopteryx*.—Original restoration, by Osborn and Knight, of *Ornitholestes* as a bird robber, capturing an *Archæopteryx*. Now regarded as an improbable interpretation of the habits of this animal**

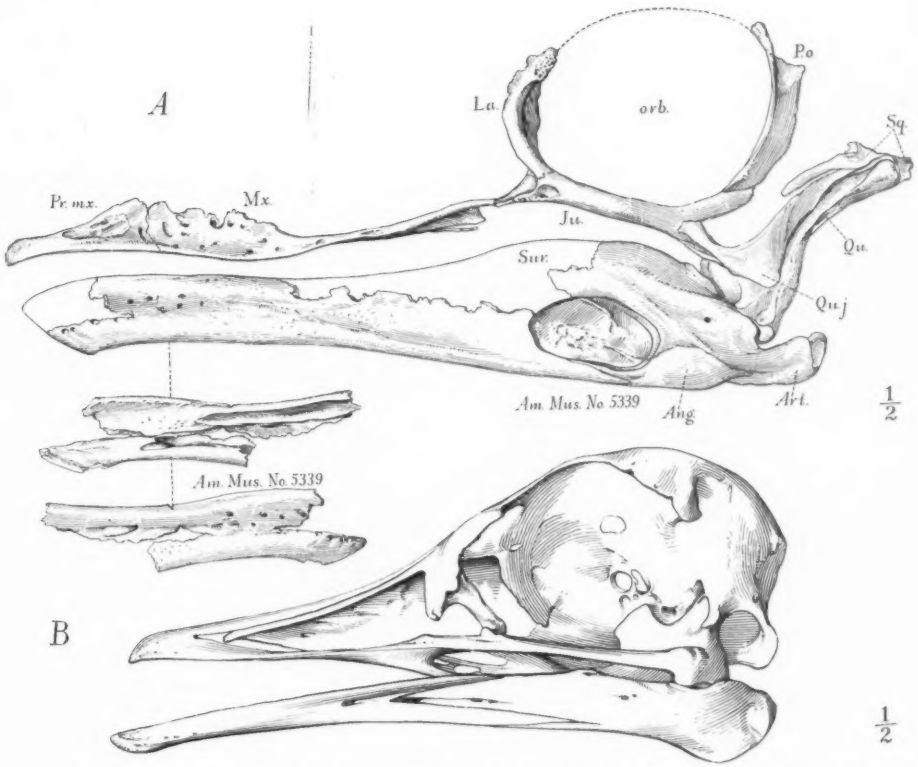
delicate skeleton of a swift-running type of dinosaur, with long, slender limbs, a very long tail, a hand provided with long, very slender fingers terminating in sharply recurved claws, a small, delicately formed head with pointed, recurved teeth.

On its arrival at the Museum this skeleton was very carefully studied by the present writer, who reached the conclusion that this little dinosaur was a carnivore and preyed upon the primitive contemporary birds, in which the powers of flight were only partially developed, and the animal was consequently given the name *Ornitholestes,* "the bird robber." The theory was that by great speed and very alert movements *Ornitholestes* was able to overtake and capture its prey.

This complete skeleton of the "ostrich mimic" dinosaur, *Struthiomimus* (of much more recent geologic age than *Ornitholestes*), was discovered by an American Museum expedition in 1914, after a search prolonged through a dozen years in the Upper Cretaceous dinosaur fields of northern Montana and southern Alberta. Only parts of skeletons had been found previously, and the skull and fore limb had never been seen. Study of these threw an entirely new light on the life habits of this type of dinosaur, and made untenable the old theory regarding the bird-robbing propensities of *Ornitholestes.* The skeleton was brought from Alberta to New York in the solid block of sandstone in which it had lain embedded through the ages

It is an interesting instance of how one discovery in science affects another that this theory of the habits of the ancient "bird robber" has become untenable through the subsequent discovery of another dinosaur, of much more recent geologic age, belonging to the same family of swift runners as the supposed "bird robber," although it cannot be regarded as a direct descendant. The first remains of this more recent animal, one of the most extraordinary dinosaurs ever discovered, were found near Denver, Colorado, in 1889, and came into the hands of Professor O. C. Marsh, of Yale University, for description. This specimen consisted of the bones of the hind foot, which were placed in a manner so closely similar to that in some of the large existing birds, such as the ostriches and rheas, that the animal received the very appropriate name *Ornithomimus,* "the bird mimic." In fact, the foot so closely resembles that of a bird that if it had been found in a period before dinosaurs were known to science, it would certainly have been described as belonging to an ancient type of bird.

Little more was known of this type of dinosaur until 1902 when a collection of limb bones belonging to similar forms was secured through explorations along the banks of the Belly River,



A Dinosaur Skull and a Bird Skull.—A—Skull of the "ostrich mimic" dinosaur. Bones of the back and lower jaw, and bony ring surrounding the eye socket (*orb.*). B—Skull of the existing ostrich (*Struthio*), to the same scale of size.

Comparison shows that the "ostrich mimic" dinosaur was not carnivorous, but that the jaws had been converted into a narrow, horny beak, not unlike that of the present-day ostrich, for eating some kind of soft food

Alberta, Canada. This type was named *Ornithomimus altus,* "the tall bird mimic," by Lambe, of the Canadian Survey. The geologic formation in which these supposed "bird-mimic" limb bones were found is considerably more ancient than the Denver Basin in which Marsh's type was discovered.

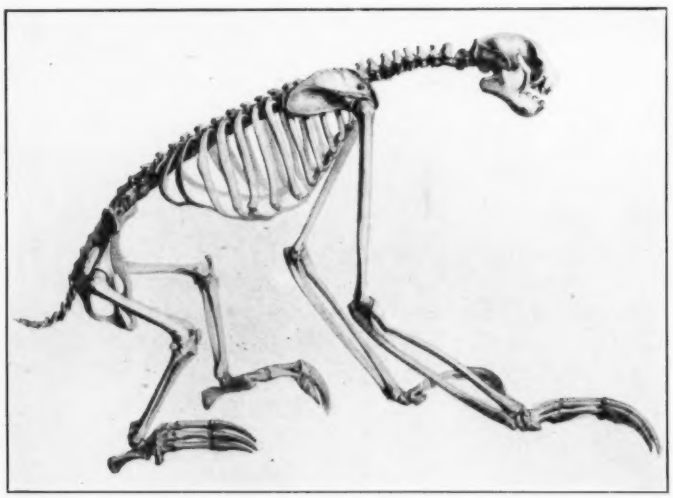
In 1902 the American Museum exploring parties entered this rich field of Upper Cretaceous dinosaur life in northern Montana and in 1909 in southern Alberta. Remains of the "bird mimics" proved to be extremely rare; but year after year the trying search was kept up in the hope of discovering a complete skeleton and of finally solving thereby the riddle of the life habits of this remarkable family of dinosaurs. Barnum Brown who was in charge of the field parties observed that these bones are almost invariably found in ancient shore deposits, indicated by wave ripple marks in the sandstones, mingled with remains of mollusks and of various forms of shore-living plant life, which affords evidence that these "bird mimics" lived along the seashores and subsisted on the animals exposed by the rising and falling tides. Finally, in 1914, the prolonged search was rewarded by the discovery of a complete skeleton of one of these animals. The specimen was exhumed with the greatest care and brought to the Museum in

the heavy block of solid sandstone in which it had lain embedded through the ages.

At the time of death the animal was entombed in the position shown, with the neck bent sharply backward so that the back of the skull rested upon the top of the hip girdle; as the rock was gradually removed from the bones in the Museum laboratory the animal was found to be in exactly the posture shown in the accompanying photograph except the limbs, which we found it necessary to alter slightly in order to expose the two sides. In the restoration the arms were outstretched in front and the legs placed in a similar bent posture as if in motion.

The discovery of this skull and fore limb occasioned one of the greatest surprises in the whole history of the science of vertebrate palæontology. It had confidently been predicted that these "bird mimics" were flesh eaters, and the present writer, at least, expected to find the skull provided with sharply pointed, recurved teeth, adapted to seizing and holding a swiftly moving and struggling prey. Consistent with this theory, it was anticipated that the fore limb and the hand would be specialized as grasping organs adapted to snatching and holding a struggling bird or small reptile, as in the theory of the ancestral "bird robber" dinosaur. On the contrary, the "ostrich mimic" dinosaur proves both in its head and in its limb structure to be not raptorial at all but probably a comparatively harmless, inoffensive creature.

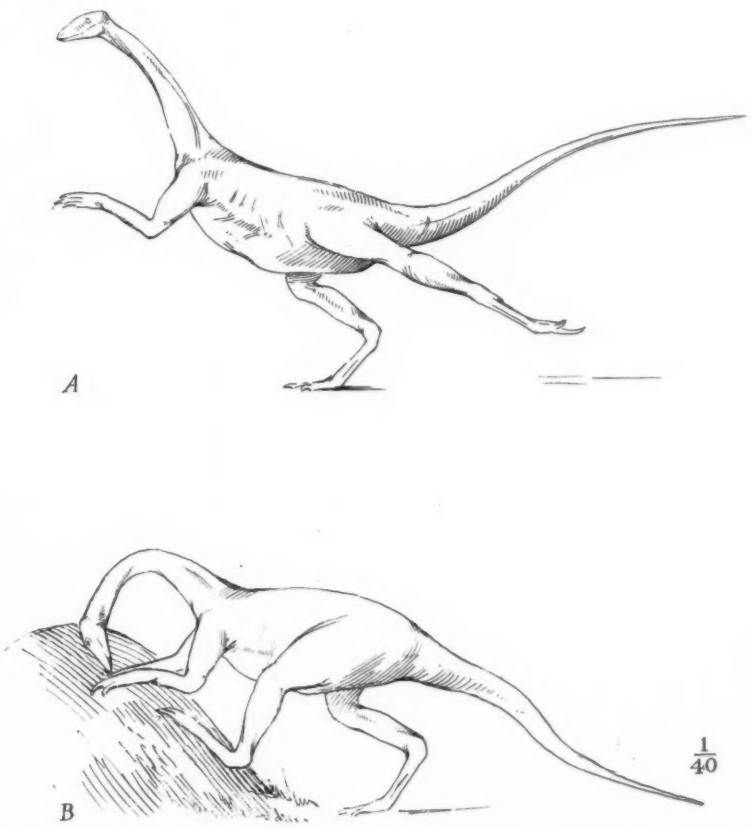
The extremely small head and slender jaws, which are entirely toothless, most nearly resemble those of the living ostrich. Unlike any dinosaur yet discovered there is a total absence of teeth and the indications are that the jaws had been converted into narrow horny beaks somewhat similar to those of the ostriches of today. The head as a whole is one third longer than in the present-day ostriches, although the tail and backbone combined are more than thirteen feet in length. The jaws are relatively deeper and more powerful than those of the ostrich, but all the areas of muscular attachment are much slighter than in any of the carnivorous dinosaurs, indicating that this animal had long since lost all the flesh-eating adaptations of the skull, and had become fitted for the consumption of some variety of relatively soft and tender food. The neck is long and extremely flexible, reminding one of



To illustrate the tree-climbing fore limb of the three-toed sloth, *Bradypus*, which in some respects resembles the fore limb of the "ostrich" dinosaur, *Struthiomimus*. *After De Blainville*

that of the ostriches, and of the Cretaceous diving bird known as *"Hesperornis."* Such a long, slender neck is in widest contrast to that of the giant carnivorous dinosaur *Tyrannosaurus.*

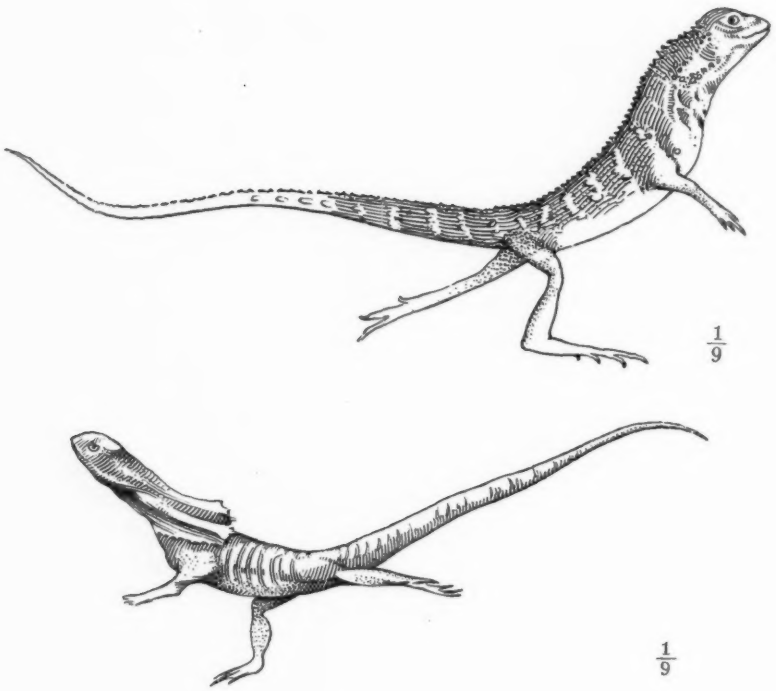
This ancient type, the "bird mimic," new and consistent theory of adaptation—namely, that this animal had actually come to mimic the ostriches both in its structure and in its browsing habits, were it not for the very peculiar and unique structure of the fore



The "Ostrich Mimic" Dinosaur, *Struthiomimus.*— A—Theory of the running pose based upon the flight of modern lizards. B—Theory of the anthill-attacking pose

is found to possess in the hind feet portions of an additional toe, which is not present in the original *Ornithomimus* specimen, and in view of the close resemblances which the animal presents in its skull, neck, and hind limbs to the existing ostriches, rheas, and other struthious birds, the author decided to name it the "ostrich mimic," *Struthiomimus.*

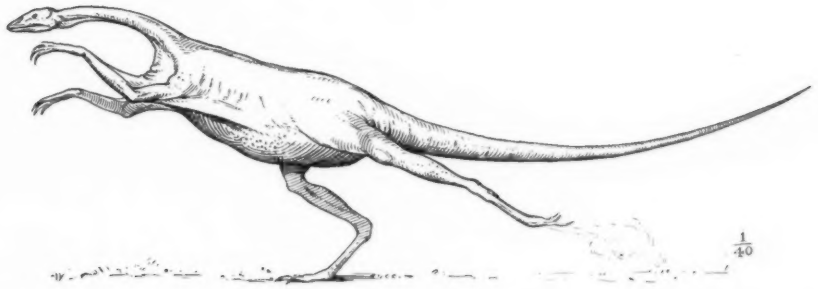
The way would be quite clear for a limb and hand, which are almost as much unlike those of the carnivorous dinosaurs as they are unlike the wing of the ostrich. It resembles, on the contrary, in some respects the fore limb of the peaceful herbivorous tree sloths of South America, such as the three-toed sloth *Bradypus,* or the two-toed sloth *Cholœpus.* The arm and forearm are long and relatively slender, as in the three-toed sloth, while the hand



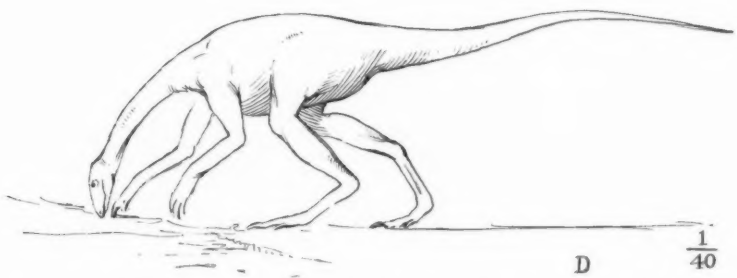
From instantaneous photographs of the Australian water lizard (upper) and the frilled lizard (lower), showing the manner in which it is believed that the small primitive, two-legged dinosaur ran. The tail acts as a balancer to the fore part of the body

consists of three digits of nearly equal length, the thumb being set off from the other fingers apparently for grasping purposes while the second and third fingers are quite closely appressed side by side as in the hand of the two-fingered sloth. The terminal bones of the fingers were provided with long, partially recurved claws adapted for grasping the limbs of trees, as in the climbing sloths, but not adapted in any way either for digging in any hard substance or for seizing an active prey. This unique combination of characters has led to a very lively discussion as to the life habits of *Struthiomimus*. All agree to abandon the idea that it was a carnivorous animal, but opinion varies between a purely herbivorous and a carnivorous interpretation.

First, as to the running motions of the animal, it is agreed that the "ostrich mimic" is certainly the swiftest reptile which has ever been discovered. It nearly rivals the modern ostriches in its powers of speed. As the fore part of the body was balanced by a long, slender, and very rigid tail, in which the vertebræ are closely articulated, it is apparent that it depended upon the balanced mode of running, similar to that which is seen in the swift bipedal movements in several of the modern lizards, such as the Australian water lizard or the frilled lizard. The habit in lizards of running upon the hind legs with the body reared upward in front has been observed among representatives of three families—namely, the Old World Agamas, and the New World Iguanids, and Tegus or race runners. In each of these forms the



"Ostrich Mimic" Dinosaur *Struthiomimus* in Flight.—Theory of the "ostrich mimic" dinosaur at full speed, with the tail balancing the body, partly assisted by a thin membrane (or patagium) on the fore limb, aiding flight as a parachute or air plane



Two Additional Theories of Habit to account for the Structure of the "Ostrich Mimic" Dinosaur.—C—Tree-browsing theory. The fore limbs are used as supports. D—Shore-living theory. The fore limbs are scratching in the sand for small Crustacea and Mollusca

running habit has evolved independently. The habit has been observed among large tree-living species as well as among lizards of diminutive size, several of the latter frequenting the deserts. The lizard appears incapable of rearing unless moving at a high rate of speed. The bipedal trait may be indicated immediately after the beginning of the dash over the ground or the lizard may rear upward after it has run a considerable distance. As observed also by the herpetologist, Raymond L. Ditmars, during the reared, running pose the front limbs appear to droop voluntarily and not to be used as balancers, but the position of the tail indicates the marked importance of this organ in balancing and there is a voluntary curving upward of the tip of the tail in order to keep the body upright. From these studies of modern lizards we may picture the running gait of the "ostrich" dinosaurs, in which the rod-like tail balances the anterior half of the body, the tail being somewhat longer than the backbone in front of it. The hind limbs are relatively longer than in any of the running lizards but relatively shorter than in the ostriches, so that we are not justified in believing that these animals quite attained the remarkable speed of the modern ostrich, which outruns the swiftest horse. The toes of the hind feet of *Struthiomimus* are purely of the running type and not adapted for scratching or digging.

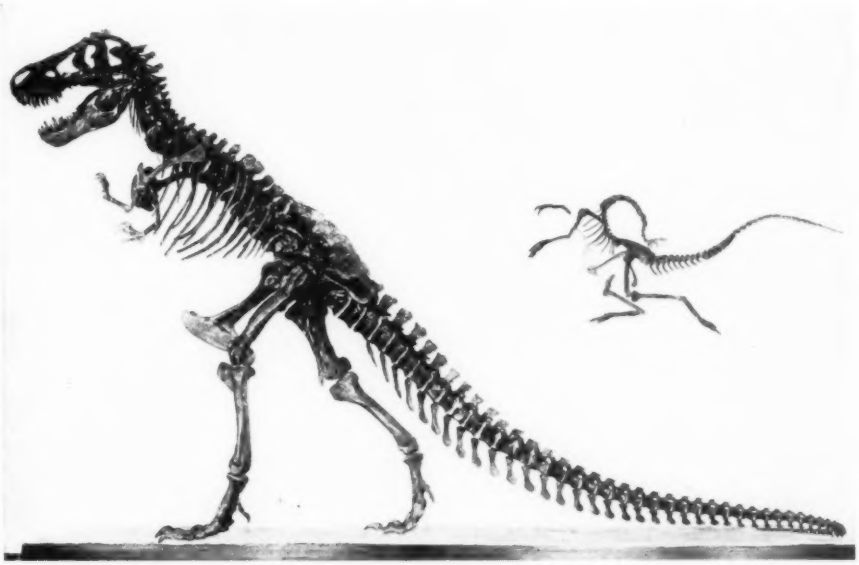
Influenced by the fact that the remains of these "ostrich mimics" are invariably found in deposits which had formed ancient seashores, in conjunction with the peculiar structure of the neck and the fore limb, Barnum Brown has suggested that the animal was a wader which fed upon small crustaceans and mollusks, using its long anterior claws partly to scrape the sand away and partly to seize the shore-frequenting animals. There are three objections to this theory: first, neither the beak nor the ends of the fingers are adapted for seizing an actively moving crustacean prey of any kind, although they may have been capable of securing the sessile mollusks, which may have been swallowed whole; also neither the structure of the beak nor of the toes is analogous to that of the shore-living birds (Grallatores), which partly live upon small invertebrates.

Another theory is that suggested by the ornithologist, C. William Beebe, that the fore limbs of the "ostrich mimics," feeble as they were, may have been adequate for attacking sandy and gravelly anthills. The difficulty with this theory is that the terminal bones in both the fore and hind feet do not afford evidence of powers for scratching or digging, nor do the upper bones of the fore limb give evidence of accommodating digging muscles.

The theory which, on the whole, seems the most probable one is that the "ostrich" dinosaurs were adapted chiefly for an herbivorous browsing pose either among low shrubs or the lower branches of trees. In balancing the body by means of the smaller branches of trees and in drawing down the limbs of trees toward the mouth, the long, sloth-like hands may have been used as the tree sloths use theirs. While the fore limb is quite powerful, it was certainly not adapted to quick movements such as are essential to the capture of an active prey. It must be admitted that no thoroughly satisfactory explanation of this limb has yet been suggested; it is evident that it was ideally adapted for some particular function or habit which had already been assumed in part in the remote an-

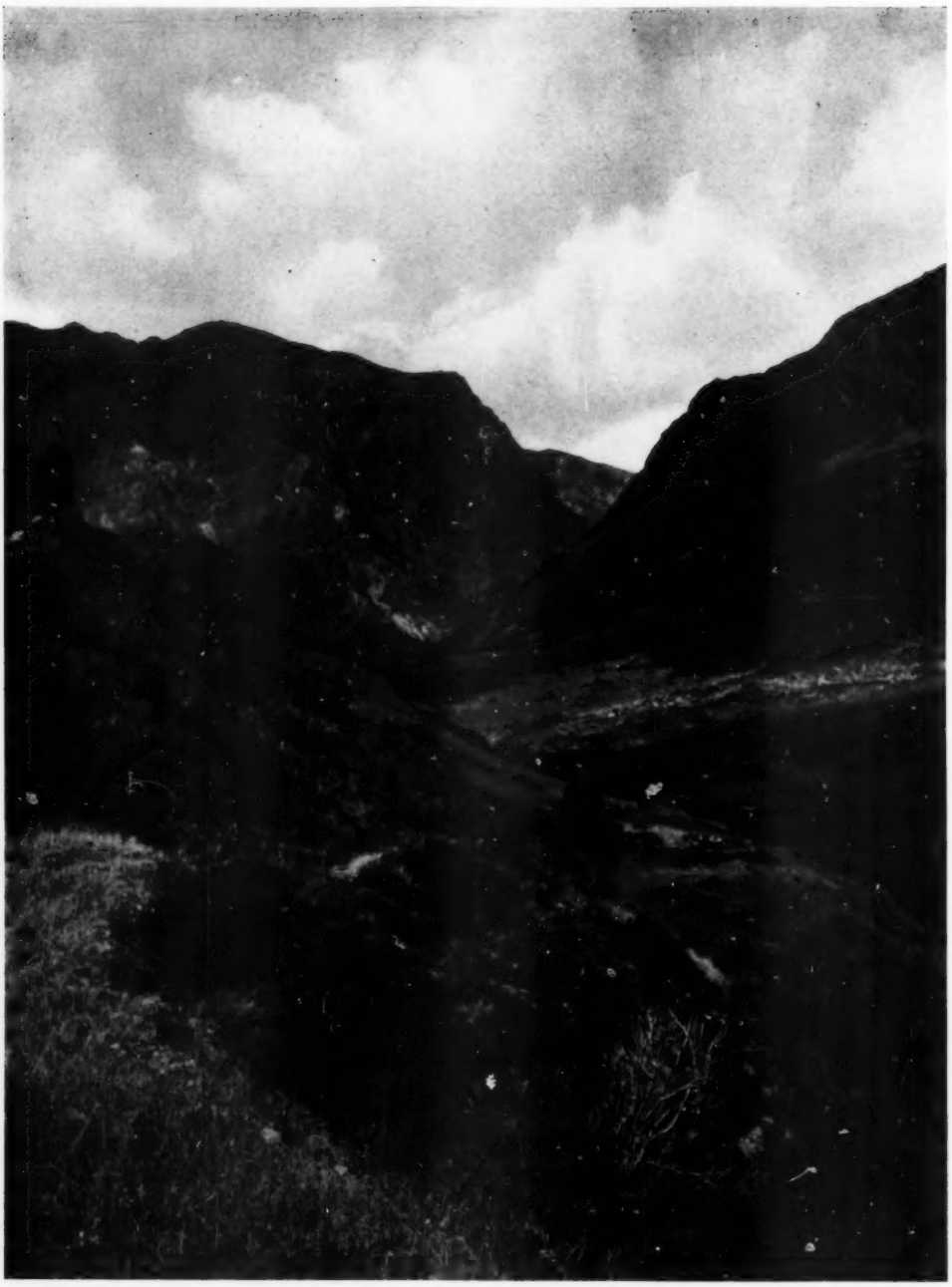
cestral form, the "bird catcher" of Jurassic time, *Ornitholestes*.

Thus the theories of several expert anatomists who have coöperated with the author in attempting to solve the riddle of this "ostrich mimic" indicate very great diversity of opinion and of interpretation. It is agreed only, first, that the animal was a very swift runner, and, secondly, that it was in all probability herbivorous and that perhaps the hand was adapted for searching out and grasping some particular form of shrub or fruit.



The "Ostrich Mimic" Dinosaur, *Struthiomimus*, and the "Tyrant" Dinosaur, *Tyrannosaurus*.—To illustrate the wide contrasts between the skeleton of the "ostrich mimic" dinosaur (right upper) and that of the "tyrant" dinosaur (left lower), animals which, notwithstanding their extreme unlikeness in adaptation to habits, descended from similar ancestors. Photographed to the same scale

The contrast which this animal presents to *Tyrannosaurus* gives us one of the greatest extremes known to science of two types adapted to most widely different habits which have, nevertheless, descended from similar ancestors: *Tyrannosaurus* extremely large-headed, with powerful teeth, very short neck, and short, powerfully clawed fore limbs and enormous hind limbs provided with very powerful recurved claws; *Struthiomimus* extremely small-headed, the toothless jaws sheathed in horn, the neck elongated and highly flexible, neither the fore nor the hind limbs adapted for seizing a live prey. In both animals the hind limbs are adapted to very rapid progression. In the case of *Tyrannosaurus* this is designed to overtake the prey, while in *Struthiomimus* this length of limb was doubtless to enable the animal to escape from enemies, among which may have been the *Tyrannosaurus* itself.



IN THE HEART OF THE VENEZUELAN ANDES

Coming down into the valley of the Rio Chama. Picturesque wheat farms occupy the shelves of the mountains up to an elevation of about eleven thousand feet

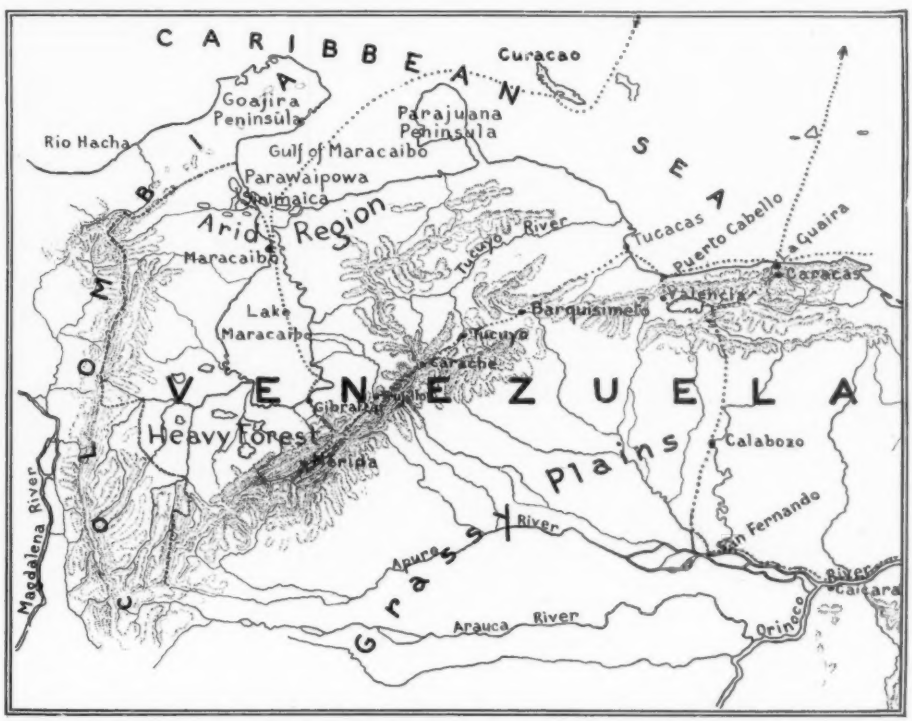
Travel Notes in Western Venezuela

By HERBERT J. SPINDEN

Illustrations from photographs by the Author

IT is a time-honored story that relates the origin of the name Venezuela and one more to be credited than the majority of place name anecdotes. When Alonzo de Ojeda, accompanied by the illustrious geographer, Amerigo Vespucci, entered the Gulf of Maracaibo in 1499 he found villages raised on piles above the water. From this circumstance he gave the name "Gulf of Venice" to the shallow sea enclosed between the arid peninsulas of Goajira and Parajuana. Those were days of flowery speech and fervid imagination: the comparison between Venice the Magnificent and the homes of humble fishing Indians in the New World struck the popular fancy and soon the whole land was known as Venezuela—Little Venice. The surviving pile-built villages north of the city of Maracaibo are still of great interest to the ethnologist and to the traveler with an eye for the picturesque.

Slipping out of Maracaibo at nightfall in a *bongo* manned by Parajuano Indians we arrived at the lagoon of Sinimaica at ten o'clock next morning. The *bongo* is a flat-bottomed boat propelled by sails or poles and fit for navigating shallow waters. The lagoon of Sinimaica is the largest of a series of small brackish lakes connected by natural canals called *caños*. There are three



Map of western Venezuela showing a portion of the route covered by the American Museum archæological reconnaissance of this part of northern South America

Among the lake dwellers in Venezuela there are considerable differences in wealth. The poorer people live in picturesque poverty in an outer line of houses

The pile-built villages in the lagoon of Sinimaica are survivals of the ancient villages of the Indians from which the name Venezuela—Little Venice—was derived. All traffic is by boat and you step from the wobbly dugout upon ladders rising from the water and find yourself on a shaky platform of small poles. Within the house you sit on your heels and eat toasted plantains and boiled manioc, while beneath you little scavenger fishes watch eagerly for crumbs that may fall through the latticed floor

villages of Parajuano Indians in this lagoon bearing the Spanish names La Boquita, La Boca del Caño, and El Barro. All are of the same character, being composed of detached clusters of houses well out from the low shore. Mangrove thickets fringe the open water where they have not been cleared away for coconut walks. There is a tide of perhaps two feet in the lagoon and the houses rise two or three feet above the high-water mark. All traffic is by canoe and you step from the wobbly dugout upon ladders rising from the water and find yourself on a shaky platform of small poles. You are courteously invited to enter. The rectangular houses have light frames and roofs of heavy thatch. Mats enclose the sides and cover portions of the floor. The fireplace is a box filled with earth. While you sit on your heels and eat toasted plantains and boiled manioc, you see through the latticed floor the upturned faces of little scavenger fishes eager to catch the crumbs that fall.

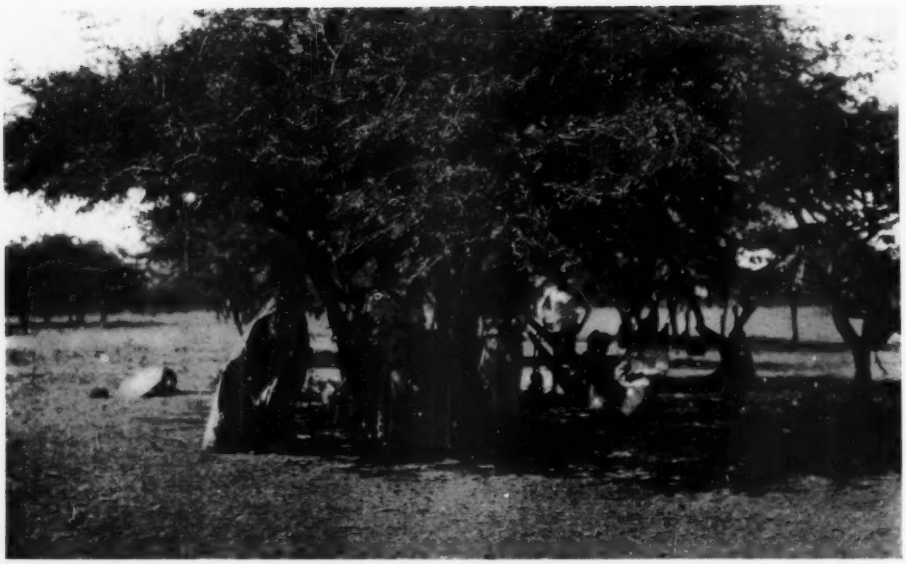
Freedom from the insect life that makes the shores unbearable may account for the custom of building houses out over the water. But it is an interesting fact that these lake dwellers also have houses upon the arid plain well back from the thicket-covered shores. The plain is a dreary stretch sparsely covered with acacias and other desert shrubs. The most conspicuous of these is the divi-divi from the seeds of which a valuable dye and tanning substance is extracted. The houses in the desert are mere roofs upon poles and as often as not the hammocks are swung under an unusually large tree. The natives take evident delight in keeping open house and in living *al fresco*.

The dress affected by the women at the present time is a voluminous gown resembling a partially deflated balloon. In ancient times the dress was doubtless much simpler and it is interesting to note that bandoleers and belts made of long strings of beads are now worn under these generous garments. Tattooing is seen upon the arms while the face is ordinarily painted with a large circle upon each cheek connected by a line across the nose. The men are sometimes seen in their ancient attire which consists of a belt and breechcloth and sometimes a poncho. Artificial wigs are worn by the leading men, and sandals with tasseled latches.

The Goajiro Indians live mostly in the interior of the desert peninsula that bears their name and their warlike habits have kept the white man from their territory. In two places they have come in contact with civilization, one at the Catholic mission of Rio Hacha in Colombia and the other at the lagoon of Parawaipowa where the Venezuelan government maintains a border garrison. The mountain range west of Lake Maracaibo (the Sierra de Perihá) is controlled by the wild and little known Motilones.

In Venezuelan histories one reads dark tales of Sir Walter Raleigh, L'Olonais, Sir Henry Morgan, and the lesser buccaneers who ravaged the Spanish Main for the glory of England and their own immediate fortune. Maracaibo was sacked again and again. Even the strongly defended Gibraltar at the southern end of Lake Maracaibo was destroyed. Today one sees at the latter site a few modern huts built round the old plaza. Paved streets can be traced out into the bush and ruined walls enter the waters of the encroaching lake. Only a graceful bell tower remains intact from former times.

Lake Maracaibo is surrounded by a coastal plain extremely dry in the north



On the arid plains back from the lakes a large divi-divi tree often serves as the sole shelter of a family, and the hammocks are swung in the shade

Weaving with cotton is still practiced by the Goajiro Indians. The products of the loom include sashes, ponchos, and hammocks

and given over to cactus and thorny shrubs, but humid in the south and clothed in heavy forest. The sierras rise abruptly from the edge of this plain and to great heights. From the southern end of the lake the Andes seem an impassable wall with their forested slopes and fogbound crests. And indeed the trails that sidewind deep gorges and climb lofty ridges, only to drop again to the roaring stream, find passes in the barren paramo some fourteen thousand feet above the sea. The transitions from one type of environment to another are sudden and startling.

A direct but little used trail for Mérida leaves the unhealthful lake port of Bobures, passes through small savannahs and stretches of dripping forest to Torondoy, a coffee center, and then ascends the Torondoy River to its very source in the paramo of Mucumpate. In the coffee region the mountain-sides have been cleared of forest and only the widespreading bucari trees retained as shade for the tender shrubs. In February these bucari trees are masses of vermilion blossoms.

Leaving Torondoy we soon find that the valley has become too dry for coffee, perhaps because the high ridges to seaward rob the winds of their rain. Small huts of mud and thatch cling to the steep slopes, and irregular fields of maize differing in age and condition make an odd patchwork of dull colors on the mountain-sides. The brighter green of plantains

Open house is kept in the desert by the Parajuano and Goajiro Indians. The peninsulas that flank the Gulf of Maracaibo are exceedingly arid. The Goajiro Indians inhabit the western one, and those groups living in the interior are almost untouched by civilization. The Parajuano Indians may once have inhabited the eastern peninsula. The old man wears the apron of olden times. He belongs to the Parajuano tribe

The Parajuano woman seated in the hammock has her face painted in a fashion peculiar to this tribe. The hammock is native of South America, and is in common use throughout Venezuela

shows itself in moist ravines. At Mucumpis Below we are not able to wheedle a noonday meal from Mrs. Sanchez who keeps the posada. After a brief rest we climb in a dizzy zigzag to Mucumpis Above where half a dozen Indian huts are clustered in a hanging valley. We now enter a second zone of humidity and soon the forest closes in about us. While the trees are not of great size the growth is very dense, with vines, canes, and ferns competing for the scanty spaces between trunks and branches. One sees the familiar plants of New England gardens in begonias that bank the trail, in fuchsias, geraniums, and the purplish Wandering Jew. Out of the blue the afternoon fog creates itself in wisps and shreds and soon the world is lost to sight. The forest opens, for we are nearing its upper limit and the trail feels its way in the white dusk along the edge of things. Mossy trees are like vanishing ghosts but reality comes in the roar of the stream a thousand feet below.

At Samuro, a rambling mud-walled structure with smoke-blackened thatch, we found a number of shivering Indians in striped ponchos. The earthen floor of the common sleeping-room was wet and the chill fog penetrated everything. Kindliness and good humor flourish but cleanliness is an unknown virtue in the mountain inns of Venezuela. One may easily picture some starving disciple of Hygeia shutting his eyes and praying while he eats, but to a peripatetic anthropologist after a hard day on the trail the earthy smell of the small greenish potatoes is grateful and comforting. Then there is a savory but uncertain stew and perhaps an egg sprinkled with the rusty salt that the government sells. On special occasions a mediæval boar's head may be brought in on a charger.

The paramo is the barren land above the timber line. In the Venezuelan Andes it begins at about ten thousand feet elevation. The transition from the upper forest zone is fairly abrupt and is marked by the dwindling of the trees and by the increase in size of the plant most characteristic of the paramo—namely, the *Espeletia*. This curious perennial, with its leafy crown felted with cotton against the cold, its awkward flower stocks set with yellow blossoms, and its thick trunk made of the dead and blackened leaves of former years, is called the *Frailejon del Paramo*—the Great Friar of the Paramo. It grows to the height of six or seven feet and in the distance is not unlike a human figure in white cowl and black cloak. Another plant of the paramo has small leaves braided along the close-growing stems. It might be mistaken for juniper were it not for the pink and yellow blossoms. A common bush resembles the huckleberry and is often heavily fruited.

From the divide one gains a splendid view of the Sierra Nevada de Mérida across the deep valley of the Chama River. This range boasts five peaks rising into the zone of perpetual snow. The highest one, La Corona, is given by latest measurements an altitude of 5002 meters (16,411 feet). The trail drops down through a valley showing signs of ancient glaciation and after two hours' travel we come to a region where wheat is raised. The little irregular fields are as stony as those of the New Hampshire hills. At Mucuchies, a town of some size with a population largely Indian, our trail joins with the better traveled one running from Valéra to Mérida.

The valley of the Chama below Mucuchies grows drier and hotter as we go down it but before Mérida is reached

Photo by Dr. Alfredo Jahn, Caracas

Highland type of Indian woman, from the region of Mérida. The native population of the Venezuelan Andes was divided into many tribes speaking different dialects. Little now remains of the ancient culture

Lowland type, from the Goajira Peninsula. These Indians are sturdy and independent; in fact the warlike habits of the men have effectually kept the white man from their territory. The women in recent times have adopted a voluminous gown resembling a partially deflated balloon. They still tattoo the arms, however, and wear, under the gown, their long strings of beads

The Andes rise as a great wall at the southern end of Lake Maracaibo and during the winter are often wrapped in fog. The trails sidewind deep gorges, and houses are often perched on steep hillsides. In the lower zone the climate is humid and the vegetation rank and tropical. Coffee is grown on the steep mountain sides under a cover of larger trees. The plantain—a coarse banana—is often cut green and toasted in thin slices as a substitute for bread

The principal plant of the paramo of the Andes—the land above timber line, beginning at ten thousand feet elevation—is the *Espeletia*, with leaves heavily felted against the cold with down that resembles cotton

conditions change for the better. Mérida is an old-fashioned city and a natural fortress, placed on a sloping bench between two streams. The University of the Andes is situated here. Coffee of superior quality is grown as well as a variety of other tropical products.

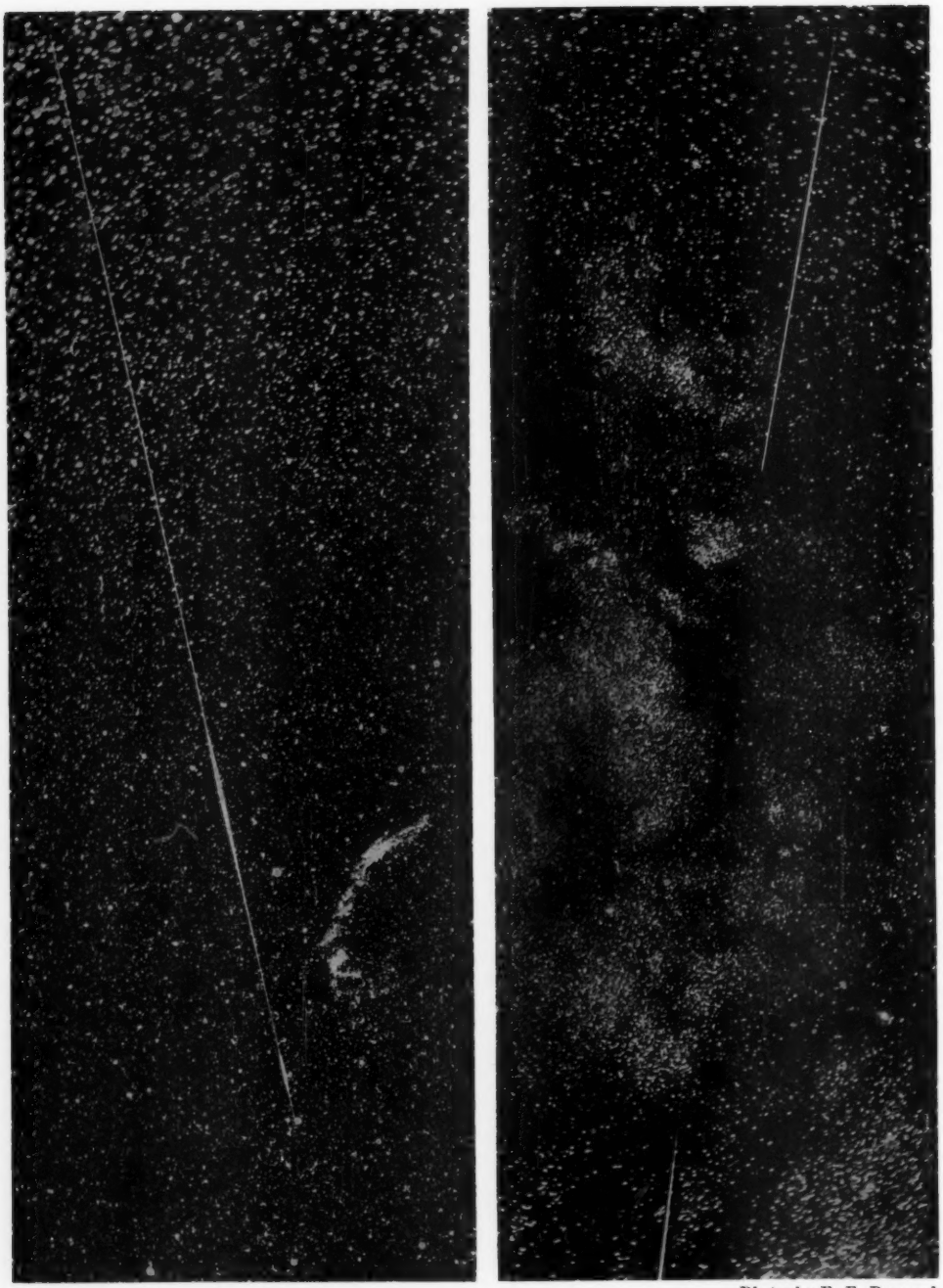
From Mérida one may travel by mule to Valéra, Trujillo, Carache, and Tucuyo in a general northeasterly direction. The Andes decrease in elevation but some of the passes are ten thousand feet or more above the sea. There are narrow forest belts as well as short stretches of true paramo. The lower country is hot and dry and when we come to the broad plain in which lie Tucuyo and Barquisimeto we find forests of cactus trees made almost impenetrable by underbrush of smaller cactus. Only where water can be put on the dry soil is agriculture possible.

The archæological explorations were extended into northern Venezuela. Next a journey was made southward across the llanos or grassy plains to Cabalozo and San Fernando de Apure.

As a purely scientific result of the expedition, it now seems clear that the earliest pottery art of Mexico and Central America, belonging on what is known as the "archaic horizon," was extended in ancient times across northern South America possibly to the mouth of the Amazon. The trail, marked by clay figurines of a peculiar style, is of greatest interest because the spread of this pottery art was associated with the first spread of agriculture, and with the historic development of plants, such as maize and beans, that are of the utmost importance in our own day and civilization.

Photo by Dr. Alfredo Jahn, Caracas

Street scene in Mérida. Five snowy peaks rise directly opposite this city and afford a brilliant contrast of tropical and arctic life



Photos by E. E. Barnard,
Yerkes Observatory, Wisconsin

METEORS IN FLIGHT

The meteors are within our atmosphere, the many stars are millions of miles away. *Reproduced from transparencies in the American Museum.*

A rapidly moving meteor is hot only in a thin skin on the surface which takes fire and is blown away in the onrush as fast as it burns, trailing behind as a stream of light. Iron meteors are so combustible that they may burn like tinder in the oxygen compressed to high heat in front of them. Thus it is that small iron masses, moving rapidly, may burn entirely away and no fraction of them reach the ground

The Flight of a Meteor

STORY OF THE FLIGHT OF STONE AND IRON METEORS THROUGH THE AIR, THEIR DIRECTION AND IMPACT WITH THE EARTH.—EXPLANATION OF THE TRAIL OF FIRE OF A "SHOOTING STAR"

By ELIHU THOMSON

At this time, when the application of science to national defense and to internal industrial development has been forced into an importance that centers the world's attention on its scientific men, any word from an American like Elihu Thomson is of especial note. While the following article concerns pure science rather than applied science, Elihu Thomson stands to Americans chiefly as an exponent of applied science. His contributions to electrical engineering have yielded him some five hundred patents, among them the very great discovery of electrical welding. He is in fact one of the few men of today whose personal achievement is having a large effect upon industrial progress. In addition he has given his coöperation to others working in applied science to such an extent that President Maclaurin, of the Massachusetts Institute of Technology, recently bestowing upon Dr. Thomson the Fritz medal of that institution, pronounced him one of the greatest teachers of his generation. With this in mind it is an unusual pleasure to read the following clear explanation of an astronomical matter which for most of us has heretofore been enveloped in vagueness.

The collections of meteorites in the American Museum of Natural History are unusually large and important, and also are unusually well arranged for study by the visitor. In a brief paper following the present article Dr. Chester A. Reeds, assistant curator of geology and invertebrate palæontology in the American Museum, has suggested a few of the collections and specimens which particularly illustrate the points made by Dr. Thomson.—THE EDITOR.

THE following may assist to a proper understanding of the physical and chemical actions which occur during the passage of a meteor into our atmosphere. Outside of our air a mass of matter such as constitutes a meteor or shooting star would necessarily be very cold. Its velocity on entering our air will be its velocity in space compounded with the earth's motion or velocity around the sun, according to the direction of its motion in relation to that of the earth. When the velocity relatively to the earth is high, the earth's gravitational force can modify the motion but slightly. In such cases, the earth's atmosphere acts so effectively as a protective sheath, that only a few of the very numerous bodies variously known as shooting stars, meteors, aërolites, and siderites ever reach the earth's surface. If the velocity is as high as thirty or forty miles per second in entering our air the crushing strains brought upon it by air resistance in its path may be great enough to break it into fragments, while the high temperature of the compressed air in front of it and opposing its motion melts or vaporizes the materials of which it is composed. Stony meteors resembling pieces of rock would naturally yield to fracture and dissemination more readily than masses of solid iron. This may account for so large a proportion of the bodies which reach the ground being composed of iron, known as meteoric iron.

Rock masses are, however, occasionally found and have perhaps survived because they were moving, in a general sense, along with the earth in its orbit, and would thus have a lower velocity in entering our air. But the iron meteors are so strong as to resist enormous crushing strains and remain intact, or

they become broken into a few pieces only, which survive further crushing.

Metallic iron is however so freely combustible that when exposed to a blast of hot, compressed oxygen, it is burned into fused iron oxide very rapidly. That is what happens to iron meteors in their flight. The air in front of them is like a blast of highly compressed gas so rich in oxygen, and so heated by compression, as to cause the iron to burn like tinder. The survival of a stony meteor or aërolite for such a time that it may reach the ground, must consequently result from its having entered our outer air at a comparatively low velocity—or upon its having had a long flight almost horizontally in the thinnest outer air, so that much of its initial speed was lost before it fell into the denser air below. On the other hand, the survival of an iron meteorite or siderite depends on its velocity being insufficient to develop crushing strains great enough to fracture it into small pieces, and upon the size of the meteoric mass itself, or of its fragments, if fractured. A small iron mass of high velocity will burn away so rapidly in the dense oxygen in front of it that the whole mass will be consumed and dissipated before any of it reaches the ground. Moreover, the energy of motion converted into heat by air resistance will not heat the body internally. The heat will be in the fused outer skin of oxide and will go into the trail or train left behind in the meteor's path. Indeed, the fused iron oxide as soon as formed on the outer surface is blown off and left behind in the hot luminous trail which marks the course of the body through the air.

If, however, the iron mass or fragment is large and the velocity has been reduced so that no further crushing or breaking can occur, then although rapidly burning on its surface, the time of flight being short, a considerable fraction of it may reach the ground or the sea surface while still moving with considerable velocity. On the land it may bury itself to a depth more or less great. In the case of an iron meteorite just considered, there will then be two sources of heat energy giving rise to luminosity. The air in front will be highly compressed and luminous while the wastage by combustion of the iron on the outer surface will result in high luminosity and a train of sparks or fire with a more ruddy light back of the meteor.

The recent industrial use of the acetylene blowpipe with excess of compressed oxygen in cutting heavy iron and steel masses, such as thick plates, is an evidence of the effectiveness of the combustion of iron in removing material. The product is of course magnetic oxide, a black oxide of iron in a fused state which is blown away as fast as it is formed, thus continually exposing unoxidized metal to continue the burning. Melted pear-shaped drops have indeed been observed falling out of the track or train left by an iron meteor in its course through the air. These are probably composed of iron cinder or melted oxide.

The flight of a meteor is so short in time that although its surface is highly heated, it has not sufficient heat conductivity to allow heat to pass from its outer surface to the interior. It enters the air in a very cold state and at no time possesses more than a thin skin of heated metal, which at once burns, liquefies, and is torn off. It can only possess, as it were, a thin layer in which the temperature gradient is very sharp or steep. The temperature limit of this layer or skin is the melting point of the oxide or of the iron itself, for, as

we have said, it is blown away just as soon as fusion occurs.

Let us turn a hot blast or even a very hot flame upon a piece of ice. Water forms rapidly and is blown off the ice but what remains is none the less ice to the end of the process. Ice is not combustible. Let us then subject a ball of wax to a forcible oxygen jet at high temperature. The wax will burn outside, melt rapidly, and as soon as melted, blow away, leaving a rapidly diminishing body of wax to the last.

An instantaneous vaporization of the whole mass of a large iron meteor is therefore not possible. Such a meteor, on entering our thin upper air, will condense the gases immediately in front of it, increasing their temperature and bringing the oxygen to a density at which the combustion of the outer skin of the moving mass begins.

If the initial velocity be extremely high, the resistance as it reaches the denser air may rise sufficiently to crush or fracture the mass. The smaller fragments will now burn and the rate of wastage by combustion be greatly increased by the fracturing, exposing a much more extended surface to burning or oxidation. If the flight is long enough, most, if not all, of the fragments may be consumed before reaching ground. But if the velocity is not high enough to cause such extensive and complete fracturing the mass may not break at all—or the fracturing soon ceases and the remaining mass is merely diminished by combustion and fusion with the continual cleansing of the surface of fused products due to the rush of gas past the meteor. When the mass has a size sufficient, it may endure the rapid waste by oxidation and a considerable fraction of it reach the earth in a solid and comparatively cold condition, embedding itself in the ground. Many fall into the sea. It would seem that a mass which has so survived will, in reaching the ground, have lost so much velocity that its striking speed will not necessarily be high as compared with that of a projectile from a high-powered gun. It will not be hot except as to a thin layer on its outer surface. Meteors rarely descend in vertical paths. Passing in a course more or less horizontal or much inclined to the vertical, they traverse many miles of dense air, and their form being usually very irregular, they meet with an enormous retardation as compared with the flight of a well-shaped cannon shot. When fragments are broken off they are poor projectiles and are retarded rapidly.

Iron meteors of round or nearly spherical outline are more likely to be gradually retarded than to undergo fracture unless their velocities are extreme.

The slower moving iron meteorites of any considerable size are almost sure to survive their flight and fall to earth, having undergone a wastage by combustion, not, however, constituting a high percentage of the total mass.

The greater number of the meteors reaching our air are naturally small, and are disintegrated or burned completely during flight. Others much larger have in many cases come to earth either entire or in fragments. There is no limit to their possible size so far as known, but evidently meteors weighing many tons are very rare. The great crater known as the "Meteor Crater," formerly Coon Butte in Arizona, a few miles west of Winslow, is by far the largest excavation known as attributable to the fall of a meteorite, or perhaps a cluster of them.

It is about forty-five hundred feet in diameter and six hundred feet deep. It

is surrounded by an upcast ridge from one hundred and fifty to two hundred feet above the surrounding plain, and fragments of meteoric iron are numerous in the slopes of this ridge and on the plain outside. At some time in the past a huge meteoric mass fell and excavated this enormous hole.

The similarity of form and proportions between the Arizona Meteor Crater and lunar craters is very striking and is strongly suggestive of the idea that the craters on the moon are the unobliterated records of innumerable giant impacts of meteoric masses; unobliterated because, though formed millions, if not billions, of years ago, the moon's surface is not subject to erosion, as the moon has no atmosphere—it never had an atmosphere, being too small to retain one. Consequently it preserves a record of all that has happened to scar it during countless ages of past time.

COLLECTIONS OF METEORITES IN THE AMERICAN MUSEUM

THE collection of meteorites in the American Museum is large and varied, and exhibits in a considerable number of specimens various features of which Dr. Thomson speaks in his paper.

In one of the alcove windows on the east side of the hall of geology and invertebrate palæontology of the Museum, there are a number of transparencies taken from photographs of meteors in flight. These were made by Dr. E. E. Barnard at the Yerkes Observatory, Williams Bay, Wisconsin. The meteors are represented by long white streaks of light. In looking at these particular photographs one should not lose sight of the fact that the meteor trail is within our atmosphere and that the multitudes of stars which are also in evidence are millions upon millions of miles away. It is also interesting to note that the light streaks are not of a uniform width throughout. Instead of being spindle-shaped in outline as we might at first suppose, they are more like a series of elongated spindles or darts joined by attenuated bands of light. Does this imply that the elements of the air

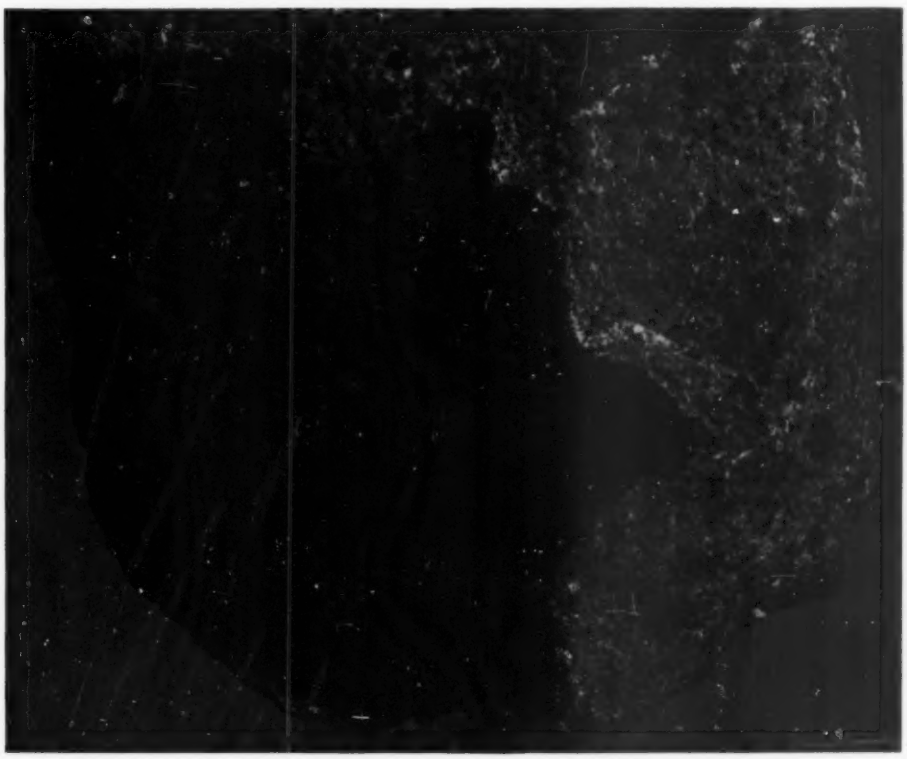
The iron meteorite has a very thin black crust, of metallic luster. The texture within remains unaltered by the fiery journey through the sky. On some iron meteorites peculiar crosslines, "Widmanstätten lines," may be etched with a weak solution of nitric acid

are unevenly mixed, that the oxygen is negligible or absent in places, and that there are "holes" in the upper atmosphere such as the aviators have experienced in the lower atmosphere? Perhaps there are a series of "crushing" stages throughout the flight of the meteor, which develop a larger number of smaller fragments and greatly increased rate of wastage by combustion (see Dr. Thomson's article, page 27). This would explain the enlargements in the meteor trail, but it does not meet the objection raised by the total disappearance of the light streak and its renewal subsequently as seen in one of the photographs.

The Museum collection contains a large number of stone meteorites (aërolites), as well as of iron meteorites (siderites), and a representative lot of the intermediate group of siderolites, which, speaking broadly, are part stone and part iron. The large stone and iron meteorites in the Museum collection are in Memorial Hall at the entrance to the Museum. The smaller stone, iron, and siderolite specimens are in alcove cases on the east side of the hall of geology and invertebrate palæontology, fourth floor, central wing.

The exterior of a stone meteorite is covered with a black crust about one thirty-second of an inch thick or less. The interior of such a specimen is unaltered, and on recently broken surfaces is usually of a light gray color. Where the aërolite has lain on or just beneath the earth's surface for a long time, both the exterior crust and chipped surfaces may be dulled by weathering, for even stone meteorites oftentimes contain considerable iron-bearing minerals which oxidize, thus discoloring the surface.

The Selma aërolite, from Selma, Alabama, in Memorial Hall, is the largest stone meteorite ever found in this country and one of the largest in the world. Several cracks are in evidence in this meteorite, but owing to the absence of a crust within the cracks, it is supposed that they developed after it reached the earth by alternate ex-



The stone meteorite has a black crust one thirty-second of an inch thick or less, and on freshly broken surfaces is light gray in color. Stone meteors, of course, break and scatter during flight much more readily than iron meteors

A HUGE HOLE MADE BY A FALLING METEORITE

Meteor Crater, formerly Coon Butte, in Arizona, is by far the largest excavation known which can be attributed to the fall of a meteorite. It measures 4500 feet in diameter, 600 feet deep, and is surrounded by an upcast ridge 150 to 200 feet high. Fragments of meteoric iron are numerous in the slopes and on the plain outside. A very comprehensive exhibit of photographs and specimens illustrative of Meteor Crater, Arizona, has been loaned to the American Museum through the courtesy of Princeton University and of Mr. D. M. Barringer, of Philadelphia. The exhibit is in one of the east alcoves of the hall of geology and invertebrate palæontology

pansion and contraction of the mass just as joint planes are developed in rocks of the earth's crust, or, that they were developed at the time of the fall by impact.

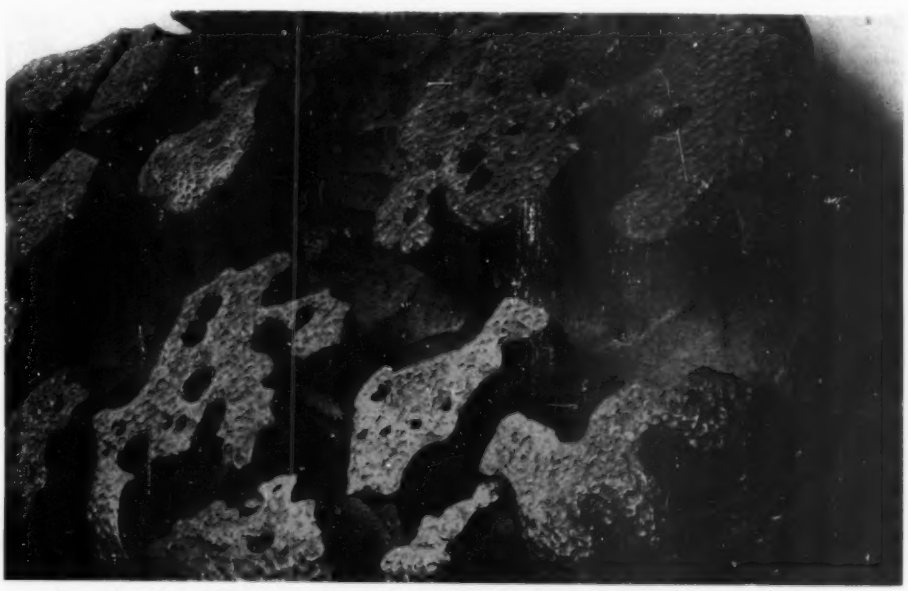
The iron meteorites have a thinner crust or skin than the stone meteorites. The iron skin has a metallic luster and is not so black as the crust of the aërolite. The interior of these specimens, like the aërolites, was not affected by their passage through the zone of fire, the atmosphere, for their texture is unaltered up to the very skin. In some iron meteorites peculiar crosslines known as "Widmanstätten" or "Neumann lines" may be etched on a polished surface by a weak solution of nitric acid. For some time it was supposed that this was a sure way of identifying meteorites, but there are a number of siderite meteorites in the collection which cannot be etched. Their outer surfaces may be chiseled into a nose, rounded, or pitted, depending upon whether they turned over in their rapid flight. The most striking instance in the Museum of a protuberance shaped in this manner by the compressed oxygen flame on a siderite, is the large Willamette, Oregon, specimen. The back side of the specimen is rough and deeply scarred, while the front has a rounded, pitted, and fluted surface.

There is also in another one of the alcove cases on the east side of the hall of geology and invertebrate palæontology one of the three collections of material which have been gathered from Meteor Crater. This exhibit has been placed here through the courtesy of Princeton University, and of Mr. D. M. Barringer, of Philadelphia. Another exhibit is at the United States National Museum, Washington, and a third one at the Crater itself, in Coconino County, Arizona.

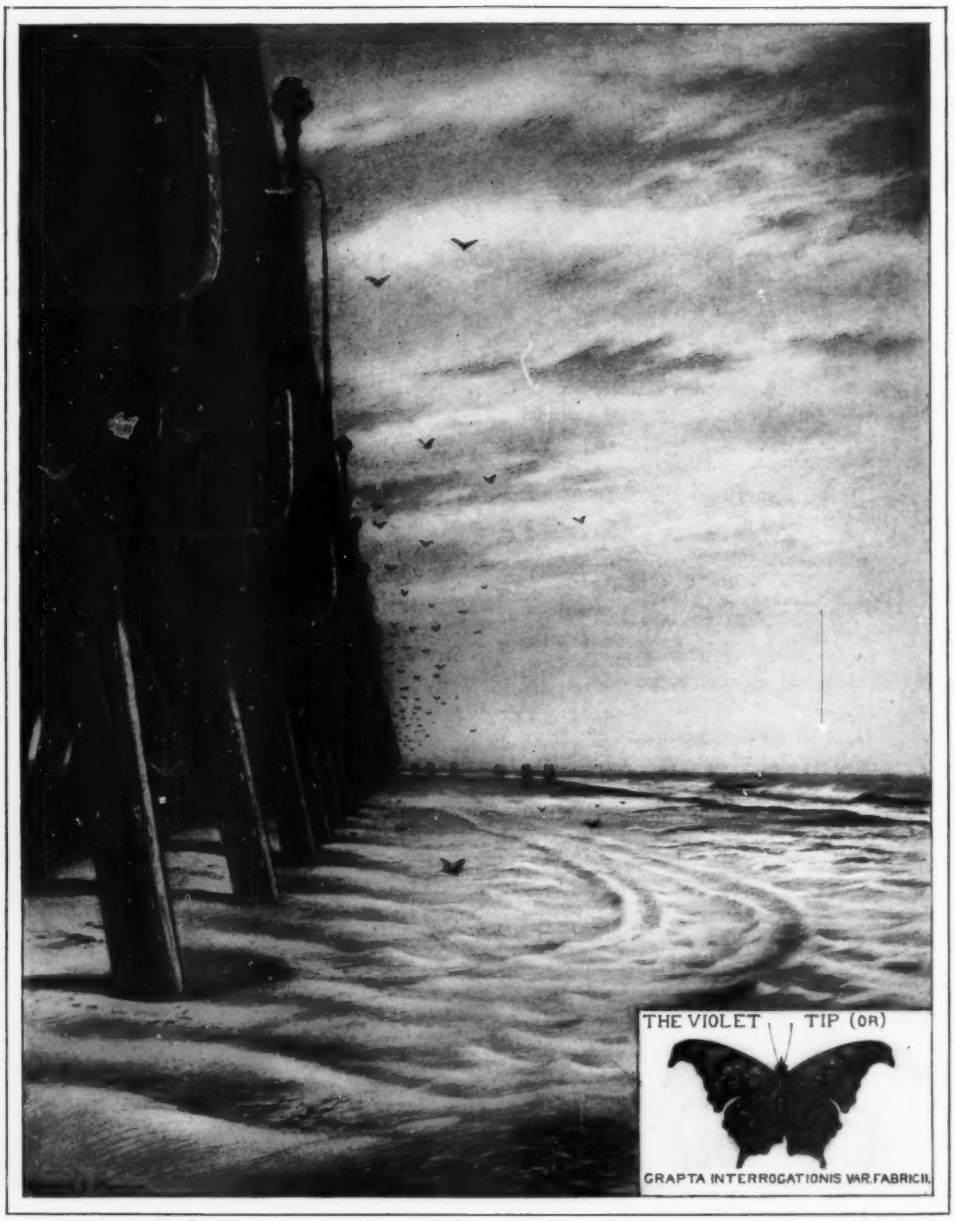
Some years ago a company was organized under the direction of Mr. Barringer, which surveyed the site and sank drill holes in the bottom of the Crater to depths greater than five hundred feet. The products of the drilling, samples of the sedimentary rock, metamorphosed sandstone, shale balls, Canyon Diablo meteorites, and ejected rock fragments are on exhibition. A booklet written by Mr. Barringer containing a number of maps, photographs, and descriptive text accompanies the exhibit.

On an average of once a week the Museum is called upon to examine supposed meteoritic material, but in most instances we are obliged to tell the expectant visitor that his specimen is some other kind of rock. It should be noted that if the thin metallic skin or black crust is absent, the specimen is in all probability not a meteorite.

CHESTER A. REEDS.



Rear view of the Willamette meteorite to show the effects of the flames, whipped backward in the speed of the flight and the fierceness of the burning. This meteorite, now in Memorial Hall of the American Museum, was found in Willamette Valley, near Oregon City, Oregon, November 9, 1906. **[See the back of the cover for another view of this meteorite]**



A SEPTEMBER MIGRATION ON LONG BEACH, LONG ISLAND

When the wind is strong from the north or northwest, many of the insects travel westward along the south side of the boardwalk. "Monarch" butterflies are in the majority, with occasional violet tips, the hunter's butterfly, peacock butterflies, and other species.

The author, through eight years' observations, has discovered for the "monarch" a route nearly one hundred miles long on the southern coast of Long Island. This is thought to be a part of the extensive coastwise route for this butterfly from Canada into the Southern States. This butterfly migrates northward also in the spring

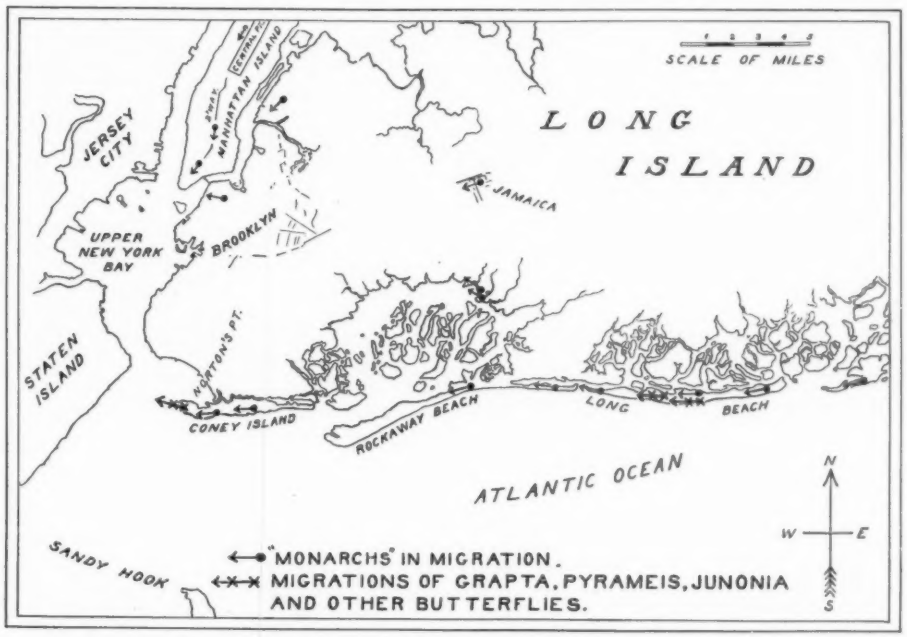
Autumn Migrations of Butterflies[1]

By HOWARD J. SHANNON

With records made on Long Island during August and September, 1916

SYSTEMATIC studies of the seasonal migrations of insects have always been attended by difficulties which are sufficiently obvious. The elusiveness, when in full flight, of the subjects themselves, the difficulty of distinguishing a merely local movement from an extensive advance, as well as the wide geographical range of various species which may be considered migratory, so that it is impossible to distinguish incoming travelers from the resident population—all these are drawbacks which have stood in the way of more definite information. Therefore it is not surprising that we have such fragmentary knowledge of the species which do migrate, as well as of the laws which govern them in their annual behavior.

In fact, there is a large and impressive body of opinion which questions whether butterflies take part in seasonal movements with any real constancy and regularity in temperate North America, except in the case of the "monarch" (*Anosia plexippus*), and the "great sulphur" (*Catopsilia eubule*), which certainly move south in autumn and north in spring. In addition to these, of course, there are the dispersal movements from the south involving certain butterflies and, more particularly, moths like the cotton moth (*Aletia argillacea*) and the velvet bean moth (*Anticarsia gemmatilis*), which



Autumn migrations of butterflies on Long Island. Fluctuation in numbers of migrating butterflies from day to day is apparently due to changes in wind direction, so largely also a controlling factor in the migration of birds. Migration is much more profuse along the Long Island coast on days when the wind is north or northwest

[1] Article and illustrations copyrighted, 1917, by Howard J. Shannon.

arrive so late in the north as to perish with the approach of winter.

This body of negative opinion as regards the regularity of seasonal movement, seems to be especially strong among European entomologists and in connection with the insect life of that continent. Yet, for reasons which need not be elaborated here, and on account of the larger number of detailed records which have been made, one would expect an opposite conclusion. In the year 1898, Mr. J. W. Tutt, the British lepidopterist, reviewed the scientific literature in an exhaustive paper and concluded that, "although nothing would have given us greater satisfaction than to have discovered in our inquiries into this subject an analogy between the migrations of insects and the migrations of birds, we can find none. The latter is regular, systematic, purposeful; the former appears to be spasmodic, irregular, uncertain, and undertaken solely on account of the absolute necessities of the time." Yet, as the writer has tried to show in a recent article,[1] a review of the literature of dragon fly migrations throughout Europe shows a constancy of direction, of season, and of route, for all the countries where records have been made.

An attempt in this review will be made to show, first—the principles of behavior governing autumn butterfly migrations on Long Island, and second—the species of butterflies which have been found migrating in observations carried out with these principles in mind.

As a result of eight years of personal observation on the southern coast of Long Island, a route of travel has been definitely established for the "monarch" butterfly. The movement begins about mid-August and lasts through September, with stragglers appearing even into late October. This route of nearly a hundred miles is believed to represent only one part of the coastwise highway leading from the Canadian territory and extending into the Southern States—an assumption which seems justified by a constantly growing mass of data in the writer's possession. It is a question, however, how many insects cross Long Island Sound—whatever may be the habit of the birds. It is probable that the insect migrants which follow the southern Long Island coast in autumn are drawn, in very large measure, from the island itself. In any case, it is evident that the travelers coming down from the north will be so deflected sideways by the east-and-west-lying ocean shore as to cause a crowded movement there—a contracted procession composed of many insects traveling side by side in company. Thus Long Beach on southern Long Island, a sandy, barren land unobscured by trees, has been chosen for these observations.

Another assisting factor has been found in the discovery that the fluctuation from day to day, and as pronounced as it is in the case of birds, is apparently due to the same cause, a change in wind direction—although the temperature change, often accompanying the shift in wind direction, doubtless acts as an important factor. Mr. C. C. Trowbridge found that when the wind was from the northeast the hawk migration along the Connecticut and Long Island shores was comparatively slight, while with the wind from the southern quarter, the movement became still less, or ceased entirely. But when the wind shifted to the north or northwest, many birds were urged southeastward into Massachusetts, Rhode Island, and into eastern Connecticut, as well as

[1] Do Insects Migrate Like Birds? *Harper's Magazine*, September, 1915.

"MONARCHS" RESTING DURING A STRONG NORTHWEST WIND

On Long Beach, Long Island, and at Coney Island, the "red-winged monarchs" have been observed during gales clustering in characteristic bunches and adding a touch of color to garden shrubs and shade trees

into southeastern Long Island. This resulted in a far more profuse migration along these shores, as the birds struggled westward against the wind on their way to the more direct flightway down the Atlantic shore. Identical behavior has been repeatedly noted in the case of the butterflies and dragon flies. So, although many observations have been made with a great variety of wind direction prevailing, days of north or northwest wind have been intentionally chosen owing to the greater opportunities they offer for the observation of less common, and in some cases, so far as the writer knows, the hitherto unnoted autumn butterfly migrants of Long Island.

Still another local feature should be noted: the fifty-foot-wide board walk that, supported on concrete pillars, extends for several miles along the beach in close proximity to the ocean. For when the winds are especially severe from the northern quarter, many butterflies travel in the protective trough or valley formed by the dune slopes and the northern side of the walk; while many are even driven beyond this barrier between them and the ocean, and in its southern lee, work their way steadily west in the measure of protection it affords.

The detailed records which follow include observations of the year 1916, and were made in the immediate vicinity of this walk. For although butterfly migrants other than "monarchs" have been noted in previous years, both here and in Connecticut, only recently have they been clearly identified by repeated capture of nearly all the species concerned. These notes were made, of course, from a fixed station, and represent only a small part of the butterflies which were doubtless traversing the beach some distance away.

AUGUST 12, 1916. *Wind northwest.*

The flightway at Long Beach is visited at 2.20 P.M.

A profuse migration of dragon flies is in progress including a greater number of species than the writer has ever before observed at one time. *Epiæschna heros, Libellula pulchella, Tramea lacerata* and *Anax junius* are in the majority with a greater number of *Epiæschna heros* than any other species. A less number of *Celithemis elisa, Libellula semifasciata, Pachydiplax longipennis, Erythrodiplax berenice* and *Sympetrum rubicundulum* are also present. All alike are traveling steadily west along the south side of the board walk, until they reach the obstructing buildings to the west when they turn diagonally northwest against the wind and pass through the streets of Long Beach. This divergent path is followed throughout the migratory season, although some individuals fly directly west without diverging. "Monarchs" are present but not in great numbers, flying side by side with the dragon flies. At 4.30 P.M. two dark-winged butterflies, almost certainly *Vanessa antiopa*, pass west and are followed by one *Basilarchia disippus.*

AUGUST 15. *Faint breeze from the south.*

10.20 A.M. A scattered procession of "monarchs" is passing steadily west. (In all following records the westward direction of flight will be understood unless another point of the compass is indicated.)
10.21. *Libellula pulchella* passes.
10.22. *Libellula pulchella* passes.
10.35. *Epiæschna heros* passes.
10.37. *Libellula pulchella* passes and is followed by *Vanessa antiopa.*
10.43. *Libellula pulchella* passes.
10.45. *Pyrameis huntera.*
11.30. *Pyrameis huntera.*
11.31. *Pyrameis huntera.*
11.35. *Epiæschna heros.*
2.35. *Pyrameis huntera.*

From 2.35 until 4.20 only one more *Libellula pulchella* and another *Pyrameis* pass. A day of sparse migration, as not one "monarch" is seen during the latter part of the afternoon.

AUGUST 20. *Wind southeast.*
11.30. *Vanessa antiopa.*
11.35. *Anosia plexippus.*
11.55. *Basilarchia disippus.*

From 12.15 until 6 P.M. no "monarchs" are seen.

SEPTEMBER 3. *Moderate wind from the northwest.*

10.15 A.M. Many thousands of "monarchs" are in migration. Dozens of *Grapta interrogationis* var. *fabricii, Colias philodice* and *Pyrameis huntera* are also passing.
10.30. *Catopsilia eubule* passes east.

From this time until 12 M. three *Junonia cœnia* and one *Grapta* pass west.
1 P.M. Two *Graptas* pass, then three *Junonias* and several *Colias philodice. Catopsilia eubule* passes east.
1.25. *Vanessa antiopa.*

2.10. *Grapta interrogationis* var. *fabricii.*
2.15. A humming bird.
3.45. *Grapta.*
3.46. *Pyrameis huntera.*
3.55. *Grapta.*

The remainder of the afternoon is spent in study of the resting "monarchs" on bayberry bushes bordering the marsh.

SEPTEMBER 4. *Wind northwest.*
8.20 A.M. Scattered procession of "monarchs."
9.05. *Vanessa antiopa.*

From this time until 10.45 six *Pieris rapæ* pass west, also one *Vanessa antiopa* and one *Grapta.*

The wind shifts, becoming south at noon when *Pieris* travels more indiscriminately here and there over the dunes.

SEPTEMBER 8. *Wind southwest.*
11.10 A.M. Scattered procession of *Epiæschna heros, Tramea lacerata* and *Libellula pulchella* passes.
11.45. *Pieris rapæ* passes in scattered groups steadily east. Fifteen or eighteen are in view at a time.
11.46. *Junonia cœnia.*
11.56. A "monarch" passes with *Grapta.*
12.35. During the last fifty minutes, *Pieris* has continued to stream steadily east in procession.
12.40. A "monarch."
12.41. *Grapta.*
12.55. *Grapta.*

Dragon flies of the three species noted have continued to pass west.
12.56. *Catopsilia eubule* passes east.
1.10. *Catopsilia eubule* passes east.

A moment afterward *Catopsilia* passes me, going west.
2.30. *Catopsilia eubule* passes east.
2.45. Dragon fly movement diminishing.
3.45. A storm gathers in the northwest and a pouring rain, accompanied by a gale from the west, sweeps over the shore. The beach is hidden by flying clouds of sand; all migration is obscured.

SEPTEMBER 9. *Wind northwest.* Clear weather, a drop in temperature to 68° in central Long Island.
10 A.M. Many thousands of "monarchs" are passing west with a lesser number of *Epiæschna heros.*
10.15. *Colias philodice.*

Several *Graptas.*

Later in the morning other *Graptas* pass, with *Colias philodice* and a number of *Pyrameis huntera.*
4.45. A humming bird.
4.50. *Pyrameis atalanta* passes.

SEPTEMBER 16. *Wind north.*

From 11.10 AM. until 12 M. steady streams of "monarchs" pass in thousands, also a few *Colias philodice,* dozens of *Pieris rapæ,* one *Basilarchia disippus,* several *Graptas* and a few dragon flies, mostly *Epiæschna heros* and *Anax junius.*
12.10. *Libellula pulchella* and *Catopsilia eubule* pass west.
12.25. A humming bird, many "monarchs" and *Pieris rapæ.*
1.10. A humming bird.

Hundreds of "monarchs" pass, also some *Graptas, Libellula pulchella, Tramea lacerata* and a few *Epiæschna heros* and *Colias philodice.*
2.15. A humming bird.
2.45. A humming bird, also *Grapta.*
3.30. A humming bird. Occasionally *Junonia cœnia* passes with a few small dragon flies. *Thecla melinus* passes in a scattered procession of considerable extent. The small red dragon flies *Sympetrum rubicundulum* pass.
4.10. A humming bird.

A day of profuse migration. "Monarchs" in the majority, then *Grapta* (forty or more), an equal number of *Pieris rapæ,* as many *Colias philodice* and a dozen or more *Junonia cœnia.*

SEPTEMBER 24. *A strong wind from the northwest.*
10.45. Thousands of "monarchs" stream west, with dozens of *Graptas, Colias philodice, Pieris rapæ* and a less number of *Junonia cœnia.* Few dragon flies are present, mostly *Anax junius, Libellula pulchella* and *Epiæschna heros.* The small red dragon fly *Sympetrum rubicundulum* occasionally passes.

Later in the day several dozen *Junonia cœnia* pass, *Pyrameis huntera* is frequent, *Graptas* not so common. A few hawks pass.[1]

From these records it seems fair to conclude that the following butterflies are habitual westward autumn migrants on Long Island: *Anosia plexippus, Pyrameis huntera, Vanessa antiopa, Grapta interrogationis* var. *fabricii, Colias philodice, Pieris rapæ, Junonia cœnia* and probably *Basilarchia disippus, Pyrameis atalanta* and *Thecla melinus,* although the records for these last three species are much less complete than the others.

When we consider this concourse of insects traveling steadily westward along southern Long Island the question naturally arises as to their exact future course, and more particularly, how and where they leave the island. To determine this point a number of later visits were made to Norton Point which is the western tip of Coney Island and

[1] Bird migrants have not been particularly noted in these records except the humming birds, which are sufficiently rare to be worthy of notice.

the extreme southwestern corner of Long Island.

SEPTEMBER 22. *Southwest wind of considerable strength.*
1 P.M. A "monarch" is flying about the western edge of the Point, and traveling southwest. Two others are floating here and there above the dunes. A *Junonia* flies from the grasses and travels southwest. *Colias philodice* flies here and there above the sand hills. Some *Pieris rapæ* rest among the grasses, one *Libellula pulchella* hawks back and forth, a *Tramea lacerata* flies south along the western edge of the shore. *Papilio asterias* rests on the lee side of a dune. No constant direction of migratory movement is noticeable.

SEPTEMBER 30. A storm on the previous day is followed by clearing, a drop in temperature, and a powerful northwest wind which becomes a gale at the shore. Upon leaving the train at Coney Island a procession of "monarchs" is seen to be traveling down Atlantic Avenue toward the west. Seven are seen within a space of fifteen feet about the station exit, others come from the east in scattered flights of a dozen or more. This procession continues westward all the way to the Point.

Here the gale sweeps so powerfully down the Narrows and across the bay as to keep the butterflies in shelter. The lee side of a clipped hedge surrounding the house which fronts the immediate Point, is spotted with the red wings of "monarchs." Others cluster in characteristic bunches on the ornamental shrubbery of gardens or even on the shade trees of the avenues. *Grapta* also rests on the hedge with *Colias philodice*. Other specimens of *Colias* shelter themselves in the grasses where *Junonia* is found.

Swallows flocking from the east breast the wind, fly high or low, then dip lower still, and by skimming just above the waves are able to leave the shore and find their way across the bay toward Staten Island. Hawks appear from the east beyond the lighthouse, strongly breast the wind, are blown back to land, only again to attempt the water passage. They try one air level, then another, and finally work their way out of sight across the bay.

"Monarchs" occasionally leave their shrubbery shelters, fly west toward the shore, feel the full force of the wind, and are blown back to land. A *Junonia* flies against the wind and is blown back like the hawks. It tries again, is once more east landward; then mounts higher still and flies fully fifty feet over the water, only, once more, to feel the full strength of the wind which carries it back to the beach where it is lost to sight among the bushes.

Farther to the east a few *Anax junius* and one *Tramea lacerata* are traveling toward the Point.

OCTOBER 1. It is milder than yesterday and the wind has abated its force, but is still from the northwest.
3.30 P.M. While the train halts in the Coney Island Railroad yards, two "monarchs" and two *Anax junius* come from the east, fly over the train, and continue west. A scattered procession is moving down the avenue.

At the Point itself, a great migration of thousands of the small dragon fly, *Sympetrum rubicundulum*, is in progress along the shore and toward the extreme tip of the land. "Monarchs" follow the same course. Some fly

Hunter's butterfly resting while on migration. This species (*Pyrameis huntera*) is a quite common autumn traveler on Long Beach

directly to the Point and travel westward out of sight, others follow the curve of the shore for a short distance northward and leave the land at this point. *Epiæschna*, in considerable numbers, and the smaller dragon flies behave in the same way, although the powerful *Epiæschna* follows the direct flightway out over the Point more often than do the others. *Grapta* and *Junonia* show the same behavior. All alike leave this shore, and against a wind that is still quite strong, beat their way west across the bay and toward Staten Island until they are lost to sight.

Migrants leaving Norton Point, the extreme southwestern corner of Long Island. The peacock butterfly (*Junonia cœnia*), accompanied by "monarchs," other species of butterflies, and dragon flies, travels westward over the waters of New York Bay apparently bound for a more southern station

What is the significance of this quite constant and consistent movement which begins at a definite date, follows a definite course, and persists for so long a period? Additional studies of the same character conducted along the Jersey coast should cast further light upon the problem, for favorable conditions should show a southward movement there; or possibly a trend toward the interior for some species. Moreover, a greater number of species should be present than we find in these Long Island movements.

A few suggestions, however, seem unavoidable. It is evident at once that, omitting *Anosia*, the "monarch" (which undoubtedly travels far south and returns in spring), the greater number of these butterfly migrants are winter hibernators in the north. This is true of *Grapta, Pyrameis huntera, Pyrameis atalanta, Vanessa antiopa* and *Junonia cœnia*. So they may combine migration with hibernation in which case they would show a partial analogy with some of our winter resident birds. For although certain species are with us throughout the year, some of those individuals which spend the winter about New York come from a region somewhat farther north, just as some of our summer individuals shift southward as autumn deepens into winter. Naturally these records are far from complete. The red admiral, for instance, was seen only once. Yet it has been reported by Mr. William T. Davis as flying west over Moriches Bay near Fire Island, on September 9, 1912, in a flock that contained at least ninety-two specimens.[1] Moreover, a recent report in *The Entomologist* describes a single-file procession of this species traveling southeast from the British Isles and toward the Continent, a further indication of its southward, autumn migra-

[1] *Journal N. Y. Entomological Society*, Vol. XX, p. 293, December, 1912.

tion. Then, too, only three *Basilarchia disippus* were discovered, but certain other migrants, almost certainly another species of *Basilarchia,* would seem to indicate that the presence of *disippus* was not accidental. Moreover, although *Thecla* was clearly identified only on September 16, it was certainly present on one or two other occasions.

It is highly significant, too, that the winter phase of the common "clouded sulphur" (*Colias philodice*) is so little noted. This is probably accounted for by the fact that this phase, whatever its nature, is passed, in many cases, in some region outside our immediate latitude. The presence of the common cabbage butterfly (*Pieris rapæ*), also, is very interesting, for, being a European importation, it recalls the many reports which exist in Old World literature regarding the extensive migrations of its close relative, the larger cabbage butterfly, *Pieris brassicæ.* In some cases the numbers involved have been so great as to give the appearance of a drifting snowstorm blowing over the water or moving steadily in one direction over the land. Indeed, one writer has noted that these butterflies seem able to alight on the water surface for a moment to rest, and then to rise again and pursue their interrupted flight in the same general direction as before.

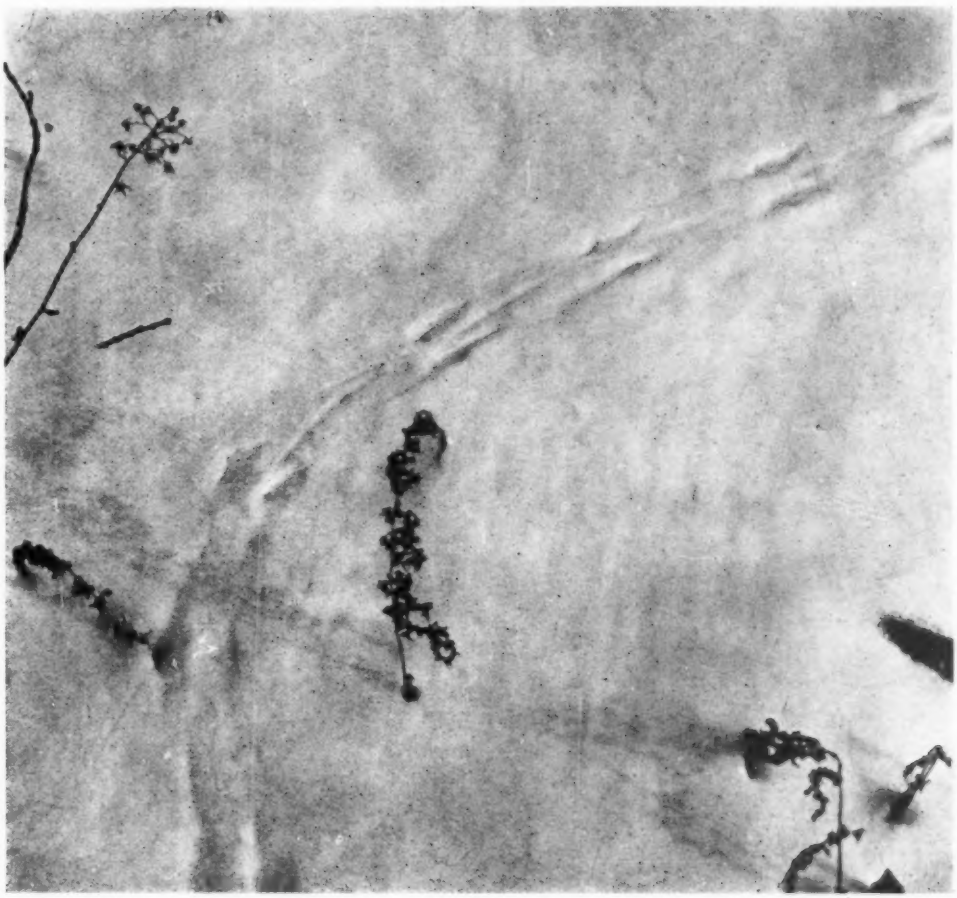
The "great sulphur" (*Catopsilia eubule*) in eastward flight is somewhat puzzling, as is the record also of *Pieris rapæ* on September 8. For that this eastward flight of *Catopsilia* is quite habitual at Long Beach, seems evident from an earlier observation on this same beach, October 19, 1915, when a single individual passed east. Yet its habitual course along the Connecticut shore is west, as shown by an extensive flight during September 22, 23, and 24, 1894, and by recent September observations by the writer. In addition to this movement, however, Mr. William T. Davis believes there is a late summer movement from the south, which would account for these eastward flights on Long Island.

Finally, after considering various explanations which might be offered, it is difficult to avoid the conclusion that, whatever their outcome, many of these flights are as truly seasonal and migratory as are those of birds. It is an interesting fact, moreover, that all of these species of butterflies and dragon flies have a wide distribution into the Southern States, so there is no impossibility in the conception of a prolonged movement for some species other than the "monarch." The exact limits of travel for each, however, and the question of a spring return for certain of the longer-lived species, can be determined only by experiments of marking the butterflies as they pass and tracing them in their later course along the coast.

Our records give certain evidence that such interesting secrets exist, and that some region or regions to the south of us undoubtedly contain the answer to problems, hitherto neglected, in the lives of some of our commonest, most familiar butterflies.

WINTER PHOTOGRAPHS FROM THE WOODS AND FIELDS OF MASSACHUSETTS WITH QUOTATIONS SELECTED FROM THOREAU'S JOURNAL ON *WINTER*[1] IN MASSACHUSETTS

BY MARY CYNTHIA DICKERSON



TRACK OF A DEER MOUSE IN THE WOODS

"A single track stretching away . . . is very handsome, like a chain of a new pattern. . . . There is a still life in America that is little observed or dreamed of. . . . How snug they are somewhere under the snow now, not to be thought of, if it were not for these pretty tracks. For a week, or fortnight even, of pretty still weather, the tracks will remain to tell of the nocturnal adventures of a tiny mouse. . . . So it was so many thousands of years before Gutenberg invented printing with *his* types, and so it will be so many thousands of years after his types are forgotten perchance. The deer mouse will be printing in the snow . . . to be read by a new race of men. (*Jan. 15*) . . . The winter was not given to us for no purpose. . . . Because the fruits of the earth are already ripe, we are not to suppose there is no fruit left for winter to ripen. . . . Then is the great harvest of the year, the harvest of thought. All previous harvests are stubble to this, mere fodder and green crop. (*Jan. 30*) . . . A fact must be the vehicle of some humanity in order to interest us. Otherwise it is like giving a man a stone when he asks for bread. . . . It must be warm, incarnated, have been breathed on at least. A man has not seen a thing who has not felt it." (*Feb. 23*)—THOREAU

[1] *Quotations used through courtesy of Houghton, Mifflin Co.*

BIRD AND SQUIRREL TRAILS IN THE CORNFIELD

". . . A strong wind from the northwest is getting the snow into picturesque drifts. . . . Take long walks in stormy weather, through deep snows in the fields and woods, if you would keep your spirits up. . . . Be cold and hungry and weary. (*Dec. 25*) . . . If you are sick and despairing, go forth in winter and see the red alder catkins dangling at the extremity of the twigs all in the wintry air, . . . promising a new spring. . . . (*Jan. 10*) . . . Staying in the house breeds a sort of insanity always. . . . (*Dec. 29*) . . . It is surprising to go into a New England town in midwinter and find its five thousand inhabitants . . . confined. . . . Scarcely here and there has a citizen stepped aside one foot to let a sled pass. And about as circumscribed is their summer life, going out from house to shop, and back to house again. . . . It is as if some vigilance committee had given notice that if any should transgress these narrow limits, he should be outlawed and his blood should be upon his own head. (*Feb. 3*) . . . To insure health, a man's relation to nature must come very near to a personal one. He must be conscious of a friendliness in her. When human friends fail or die, she must stand in the gap to him." (*Jan. 23*) —THOREAU

THROUGH THE BLUEBERRY PASTURE

". . . There is but little life and the objects are few, it is true. We are reduced to admire buds, even like to partridges, and bark, like the rabbits and mice, the great red and forward looking buds of the azalea, the plump red ones of the blueberry. . . . (*Jan. 10*) . . . The stems [of the blueberry] rise up in a winding and zigzag manner. . . . Judging from those whose rings I have counted, the largest of those stems must be about sixty years old. (*Dec. 24*) . . . To such an excess have our civilization and division of labor come that A., a professional huckleberry picker, has hired B.'s field, . . . C., a professed cook, is superintending the cooking of a pudding made of some of the berries, while Professor D., for whom the pudding is intended, sits in his library writing a book, a work on the Vaccinieæ, of course. And now the result of this downward course will be seen in that book. . . . There will be none of the spirit of the huckleberry in it. The reading of it will be a weariness to the flesh. . . . I believe in a different kind of division of labor, and that Professor D. should divide himself between the library and the huckleberry field." (*Dec. 26*)—THOREAU

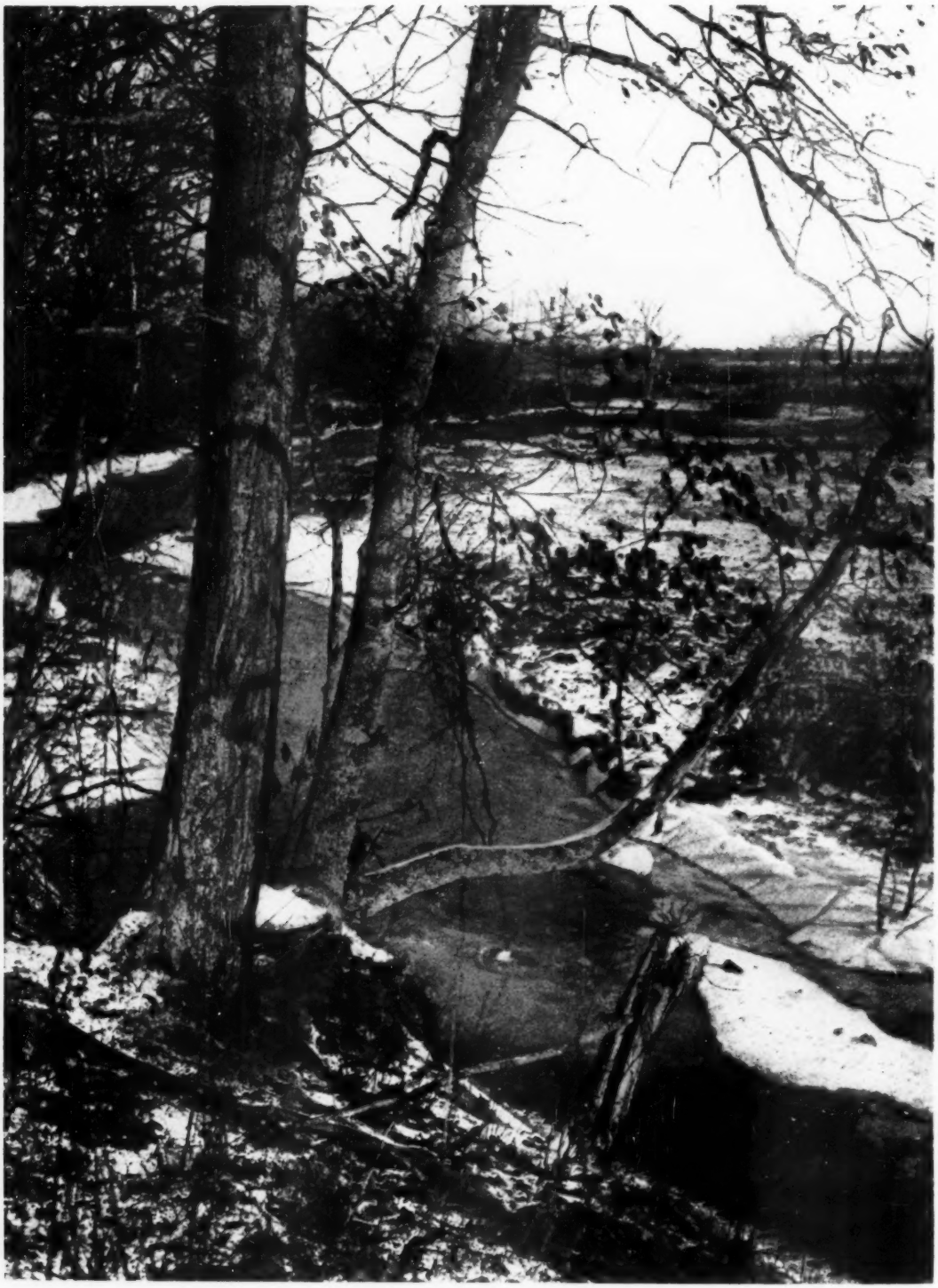
THE SILENCE OF WINTER

"Some three inches of snow fell last night and this morning, concluding with a fine rain, which produced a slight glaze, the first of the winter. This gives the woods a hoary aspect, and increases the stillness by making the leaves immovable even in a considerable wind. (*Dec. 24*)

. . . What are threescore years and ten hurriedly and coarsely lived to moments of divine leisure, in which your life is coincident with the life of the universe. We live too fast and coarsely. . . . We consult our will and our understanding and the expectation of men, not our genius. . . . Our moment of life costs many hours, hours not of business, but of preparation and invitation. . . . That aim in life is highest which requires the highest and finest discipline." (*Dec. 28*)—THOREAU

A WET AND HEAVY SNOW

"You glance up these paths, closely embraced by bent trees, as through the side aisles of a cathedral, and expect to hear a choir chanting from their depths. (*Jan. 30*) . . . What a comment on our life is the least strain of music! It lifts me above all the dust and mire of the universe. . . . Almost all, perhaps all, our life is, speaking comparatively, a stereotyped despair, *i.e.*, we never at any time realize the full grandeur of our destiny. We habitually, forever and ever, underrate our fate. (*Jan. 13*) . . . There are in music such strains as far surpass any faith which man ever had in the loftiness of his destiny. He must be very sad before he can comprehend them. . . . Music hath caught a higher pace than any virtue that I know. It is the arch reformer. It hastens the sun to his setting. It invites him to his rising. It is the sweetest reproach, a measured satire. (*Jan. 8*) . . . When we are so poor that the howling of the wind shall have a music in it . . ." (*Jan. 18*)—THOREAU



A COMPANIONABLE COUNTRY

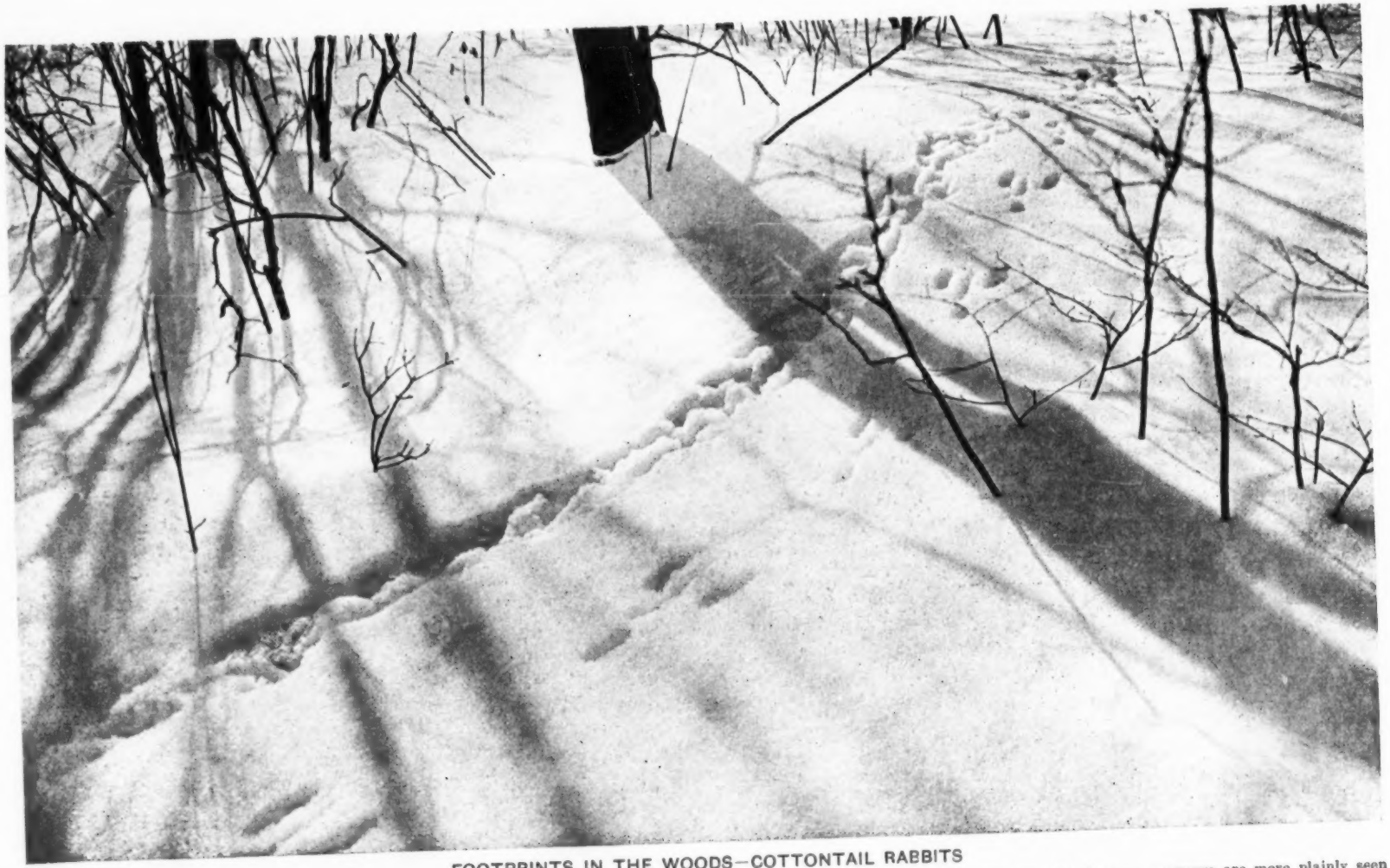
"Skated up the river . . . in spite of the snow and wind. . . . We went up . . . and came down . . . again with the wind and snow dust, spreading our coat tails, like birds, though somewhat at the risk of our necks, if we had struck a foul place. I found that I could sail on a tack pretty well. . . . Sometimes we had to jump suddenly over some obstacle, which the snow had concealed, to save our necks. It was worth the while for one to look back against the sun and wind, and see the other sixty rods off. . . . In the midst of . . . curling snow steam, he sweeps and surges this way and that, and comes on like the spirit of the whirlwind. At Lee's Cliff we made a fire, kindling with white pine cones. . . . Then cast on some creeping juniper wreaths and hemlock boughs to hear them crackle." (*Feb. 3*)—THOREAU

NEW ENGLAND BOG AND MEADOW

"In severe winters the quails venture out of the woods, and join the poultry of the farmer's yard. . . . It is remarkable that this bird, which thus half domesticates itself, should not be found wholly domesticated before this. (*Feb. 7*) . . . I am glad to find that our New England life has a genuine human core to it; that inside, after all, there is so little pretense and brag. . . . The middle-aged son . . . helps his old mother about her work when the field does not require him. (*Dec. 26*) . . . If there are any who think that I am vainglorious, that I set myself up above others, and crow over their low estate, let me say that I could tell a pitiful story . . . if my spirits held out to do it. I could encourage them with a sufficient list of failures. . . . I think worse of myself than they can possibly think of me, being better acquainted with the man." (*Feb. 10*)—THOREAU

THOROUGHWORT TO THE MIND

"It is bitter cold with a cutting northwest wind. . . . There is nothing so sanative . . . as a walk . . . alone in distant woods or fields, in unpretending sproutlands, or pastures tracked by rabbits, even in a bleak, and, to most, cheerless day like this. . . . This cold and solitude are friends of mine. . . . I come to my solitary woodland walk as the homesick go home. . . . I enter some glade in the woods perchance, where a few weeds and dry leaves alone lift themselves above the surface of the snow, and it is as if I had come to an open window. I see out and around myself. . . . This stillness, solitude, wildness of nature, is a kind of thoroughwort or boneset to my intellect. This is what I go out to seek. . . ." (*Jan. 7*)—THOREAU

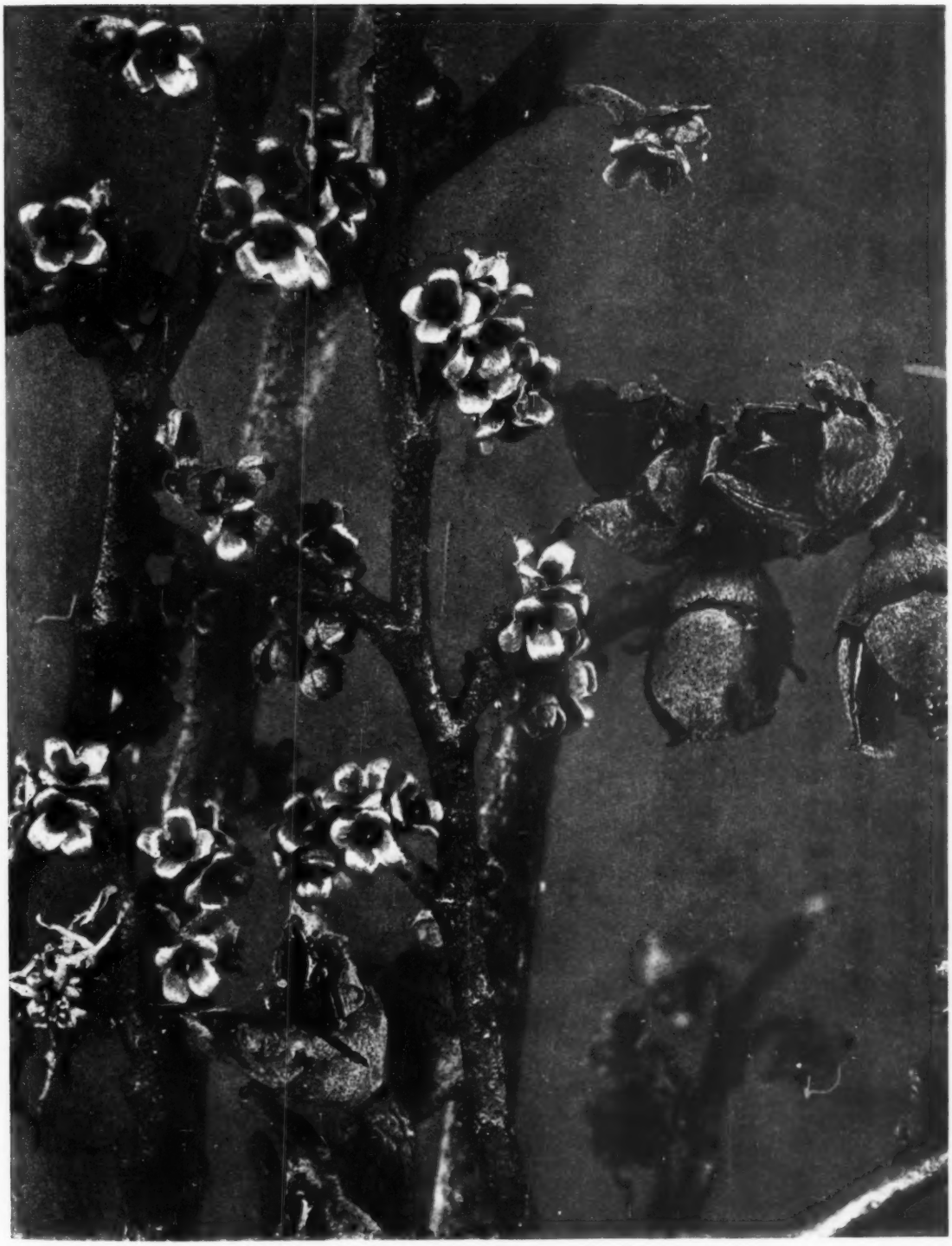


FOOTPRINTS IN THE WOODS—COTTONTAIL RABBITS

"The snow is the great betrayer. It not only shows the tracks of mice, otter, etc., etc., which else we should rarely, if ever, see, but the tree sparrows are more plainly seen against its white ground, and they in turn are attracted by the dark weeds it reveals. . . . We might expect to find in the snow the footprint of a life superior to our own, of which no zoölogy takes cognizance. Is there no trace of a nobler life? . . . Why do the vast snow-plains give us pleasure, the twilight of the bent and half-buried woods? Is not all there consonant with virtue, justice, purity, courage, magnanimity; and does not all this amount to the track of a higher life than the otter's—a life which has not gone by and left a footprint merely, but is there with its beauty, its music, its perfume, its sweetness, to exhilarate and re-create us?" (*Jan. 1*)—THOREAU

A WINTER GOOD NIGHT

". . . Stood within a rod of a downy woodpecker on an apple tree. How curious and exciting the blood-red spot on its hind head! I ask why it is there, but no answer is rendered by these snow-clad fields. . . . It looks . . . as if it had a black cassock open behind and showing a white undergarment. . . . It is briskly and incessantly tapping all round the dead limbs, but hardly twice in a place, as if to sound the tree, and so see if it has any worm in it. . . . How briskly he glides up or drops himself down a limb, creeping round and round, and hopping from limb to limb, and now flitting with a rippling sound of his wings to another tree. (*Jan. 8*) . . . The snow buntings and the tree sparrows are the true spirits of the snowstorm. They are the animated beings that ride upon it and have their life in it. (*Jan. 1*) . . . You hear the lisping music of chickadees from time to time, and the unrelenting, steel-cold scream of a jay, unmelted, that never flows into a song, a sort of wintry trumpet, screaming cold, hard, tense, frozen music. . . ." (*Feb. 12*)—THOREAU



YELLOW WITCH-HAZEL FLOWERS OF MIDWINTER

"Perhaps what most moves us in winter is some reminiscence of far-off summer. *(Jan. 12)*

My difficulties with my friends are such as no frankness will settle. . . . Explanation is not what is wanted. Friendship is the unspeakable joy and blessing that result to two or more individuals who from constitution sympathize. Such natures are liable to no mistakes, but will know each other through thick and thin. . . . Who are the estranged? Two friends explaining. *(Dec. 21)* . . . O Happiness, what is the stuff thou art made of?—Is it not gossamer and floating spider's webs? a crumpled sunbeam—a coiled dew-line settling on some flower? What moments will not supply the reel from which thou mayst be wound off? Thou art as subtle as the pollen of flowers and the sporules of the fungi." *(Jan. 20)*—THOREAU

A SPRING WITH GREEN CRESS

"Is this not the plant which most, or most conspicuously, preserves its greenness in the winter? . . . It is as green as ever, and waving in the stream as in summer. (*Dec. 22*) . . . When I break off a twig of green-barked sassafras, as I am going through the woods now, and smell it, I am startled to find it fragrant as in summer. It is an importation of all the spices of Oriental summers . . . very foreign to the snow and the oak leaves. (*Feb. 9*) . . . I listen to the sharp, dry rustle of the withered oak leaves. This is the voice of the wood now. . . . It sounds like the roar of the sea, and is inspiriting like that, suggesting how all the land is seacoast to the aërial ocean. (*Jan. 2*) . . . Sound and still youthful senses, not enervated by luxury, hear music in the wind and rain and running water. One would think, from reading the critics, that music was intermittent, . . . dependent on some Paganini or Mozart . . . but music is perpetual, and only hearing is intermittent." (*Feb. 8*).—THOREAU

dependent on some Paganini or Mozart . . . but music is perpetual, and only hearing is intermittent." (Feb. 5). Thoreau

THE WOODLAND IN JANUARY

". . . Such things are beautiful, they have a high use which dollars and cents never represent. . . . Such things educate far more than any hired teachers, preachers, or any system of school education. . . . If we have the biggest bowlder in the country, then it should not belong to an individual nor be made into a doorstep . . . natural objects of rare beauty should belong to the public. Not only the channel, but both banks of every river should be a public highway. . . . (*Jan. 3*) . . . When, as now, in January a south wind melts the snow, and the bare ground appears . . . a perfume seems to exhale from the earth itself . . . I derive a real vigor from the scent of the gale wafted over the naked ground, as from strong meats, and realize again how man is a pensioner of nature." (*Jan. 8*)—Thoreau

A WOODLAND PATH

"The snow has fallen so gently that it forms an upright wall on the slenderest twig. The agreeable maze which the branches make is more obvious than ever, and every twig thus laden is as still as the hillside itself. . . . The sight of the pure and trackless road . . . would tempt us to begin life again. (*Dec. 26*) . . . I sometimes think that I may go forth and walk hard and earnestly, and live a more substantial life, get a glorious experience, be much abroad in heat and cold, day and night, live more, expend more atmospheres, be weary often. . . . But then swiftly the thought comes to me, Go not so far out of your way for a truer life, keep strictly onward in that path alone which your genius points out, do the things which lie nearest to you, but which are difficult to do, live a purer, a more thoughtful and laborious life, more true to your friends. . . ." (*Jan. 12*)—THOREAU

EVEN SPROUTLANDS INCREDIBLY FAIR

". . . In certain places, standing on their snowiest side, the woods were incredibly fair, white as alabaster. Indeed, the young pines reminded you of the purest statuary, and the stately, full-grown ones, towering around, affected you as if you stood in a Titanic sculptor's studio. . . . How new all things seem! . . . It is like the beginning of the world. . . . The world is not only new to the eye, but is still as at creation. Every blade and leaf is hushed, not a bird or insect is heard. . . . (*Jan. 20*) . . . Such is beauty ever, neither here nor there, now nor then, neither in Rome nor in Athens, but wherever there is a soul to admire. If I seek her elsewhere because I do not find her at home, my search will be a fruitless one. (*Jan. 21*) . . . I would be as clean as ye, O Woods." (*Dec. 29*)—THOREAU

A SUNSET SKY

"The man is blessed who every day is permitted to behold anything so pure and serene as the western sky at sunset, while revolutions vex the world. There is no winter necessarily in the sky, though snow covers the earth. The sky is always ready to answer our moods. We can see summer there or winter. (*Dec. 27*) . . . Whatever we see without is a symbol of something within. . . . The lover of contemplation, accordingly, will gaze much into the sky. Fair thoughts and a serene mind make fair days. (*Jan. 17*) . . . I witness a beauty in the form and coloring of the clouds which addresses itself to my imagination, . . . excites me, stirs my blood, makes my thoughts flow. . . . If there is not something mystical in your explanation, . . . it is quite insufficient. . . . What sort of science is that which enriches the understanding, but robs the imagination? . . . If we knew all things mechanically merely, should we know anything really?" (*Dec. 25*)
—THOREAU

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The Telephoto Lens in Cinematography

WITH ESPECIAL REFERENCE TO ITS APPLICATION IN THE PROBLEMS OF BIRD PHOTOGRAPHY

By NORMAN McCLINTOCK

Illustrations from the Author's motion picture films taken with regular lens and telephoto

THE application of the telephoto lens to still photography is well known. Those who have ever tried telephoto work are, of course, thoroughly familiar with the well-known law, that the increase in the exposure required is directly proportional to the square of the magnification used. This law is based upon the assumption that the diameter of the positive element of the telephoto system is constant. When the telephoto lens is applied to cinematography all of the difficulties encountered in still photography are present, with the addition of new problems. For instance, it is generally impossible materially to increase the duration of the exposure in cinematographic work, in order to conform with the above-mentioned law, for the reason that sixteen pictures per second must be made and the longest permissible exposure for each picture is about one thirty-second of one second. In view of this exposure limitation, it will be obvious that the only alternative in motion picture work is to employ a telephoto combination having larger glass cells than commonly used in still photography, so that sufficient light can be had to make exposures of not less than one thirty-second of a second duration. This will explain why it is advisable in cinematographic telephoto work to make each telephoto lens complete in itself and not consisting of a negative element which is to be added to the regular positive lens.

The cinematographic telephotos have their diaphragm stops graduated on the lens mounts, as on all ordinary lenses, and accordingly no special calculations for the exposures are required.

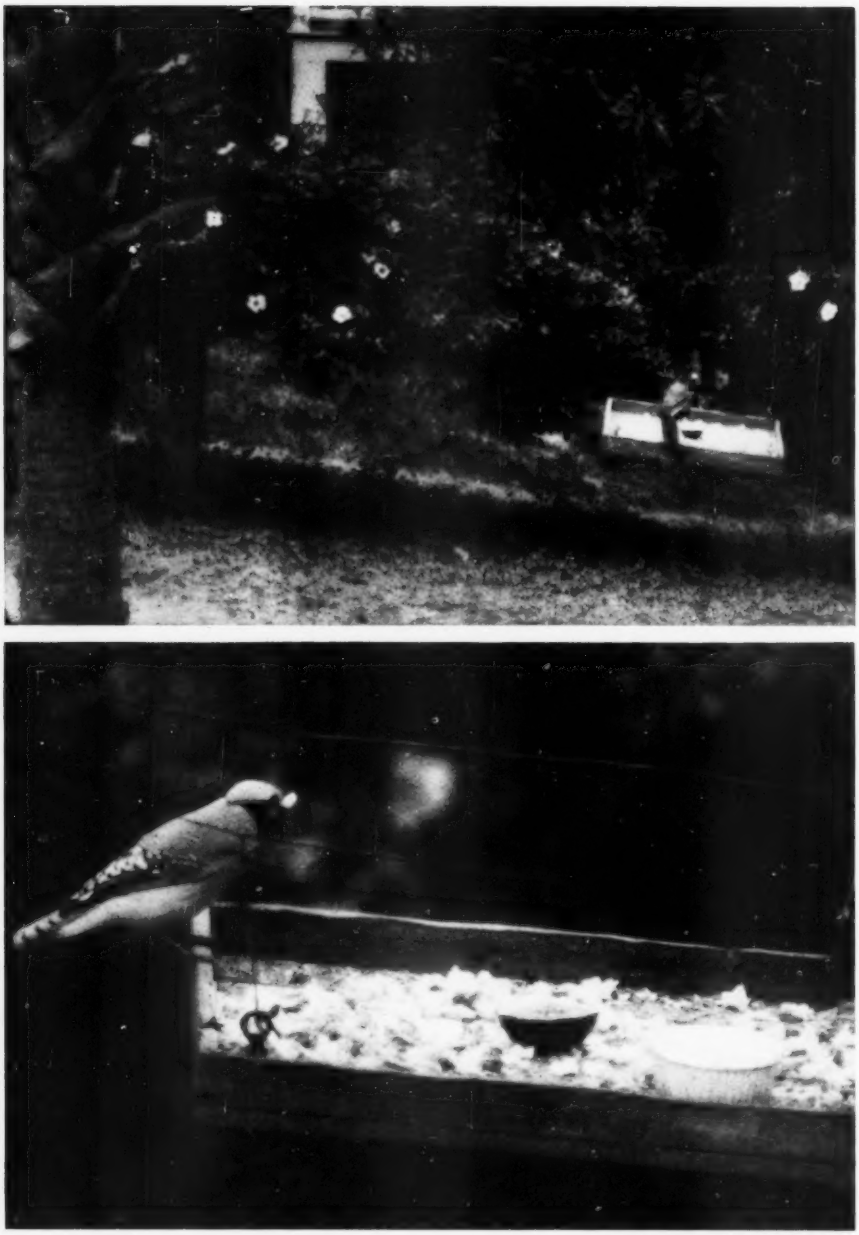
Another, and all important, problem in cinematograph telephotography is accurate focusing. Owing to the great magnification on the screen of the motion picture positive film, which is sometimes as much as, or even more than, three hundred diameters, the greatest care in focusing is necessary. And, on the other hand, the longer the focal length of the lens used the greater is the difficulty, by reason of the rapid decrease in the so-called depth of field with the increase in the magnification. In the telephoto bird work which I have done, I have used an auxiliary magnifying lens for the sharp focusing of objects on the ground glass.

The most serious difficulty, however, to be met with in making telephoto motion pictures is the question of vibration. Vibration is an ever-present enemy of the field cinematographer, which has to be constantly fought, even with the use of regular lenses, and when telephotos are used the problem is far harder, for not only is the desired image enlarged by the use of a telephoto lens but any vibrations present are correspondingly magnified.

It is the act of grinding the camera combined with the necessity of having a combination of interior moving parts that is apt to set up vibrations, which may be most disastrous as far as satisfactory screen results are concerned. I use the term "screen results" advisedly, for one may secure a perfect series of individual still pictures on a motion picture film and yet show a most disagreeable and prohibitive relative vibration between the positions on the screen of the separate pictures when projected. This question of vibration is, of course, a mechanical and not an optical problem.

In my bird work I use a heavy camera, a heavy tripod, and brace the telephoto lenses. Even then, I am often troubled with vibration, especially when using my largest telephoto lens, which has an equivalent focus of seventeen inches and a maximum speed of F 6. This lens gives a magnification of eight and one half diameters, in comparison with the standard two-inch lens.

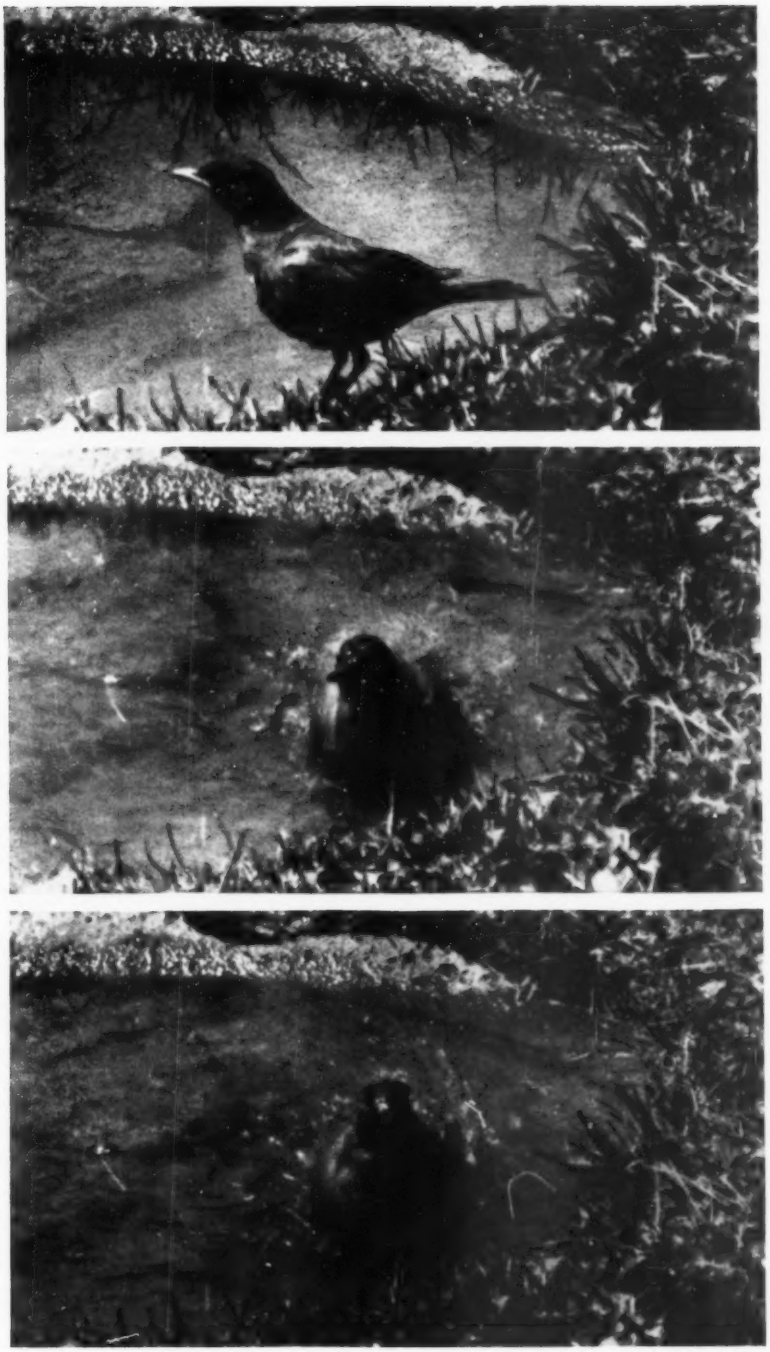
In order to make a comparison with still photography, to show the relative size of this particular telephoto lens to the size of the picture secured, it will be interesting to



From motion picture film
by Norman McClintock

COMPARISON BETWEEN 3″ LENS AND 12″ TELEPHOTO

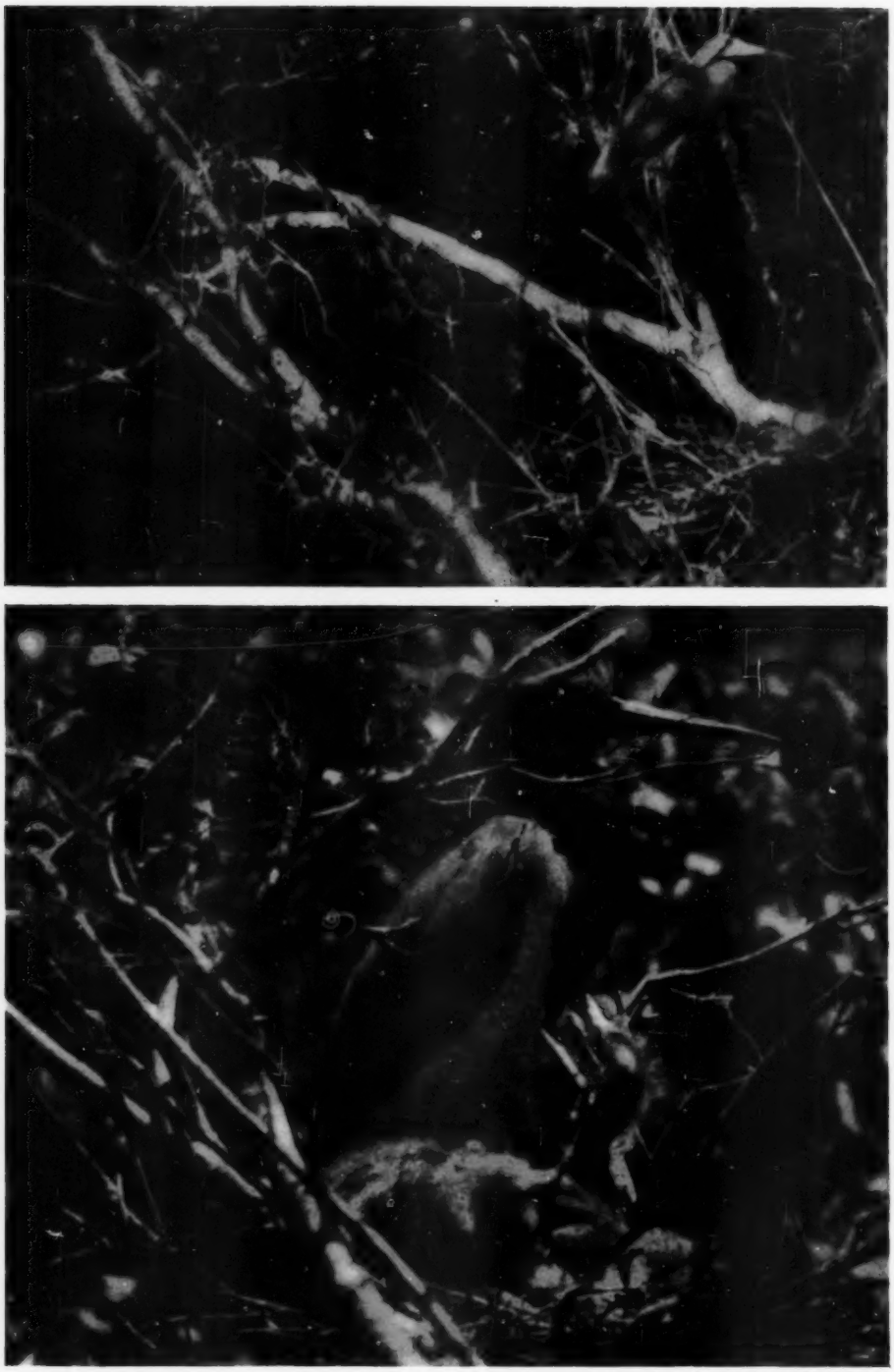
Both photographs show a swinging food shelf for birds on the estate of the Honorable George Shiras, Ormond Beach, Florida, and were taken from the same standpoint. The upper picture was made with a 3″ motion picture lens, the lower with a 12″ telephoto



From motion picture film
by Norman McClintock

ROBIN IN A BIRD BATH: A TELEPHOTO TRIUMPH

With ordinary apparatus it is well-nigh impossible to get near enough to photograph the adult robin without the use of a blind. With the 17″ telephoto lens at twenty-five feet one can secure an image of the same film size as with the standard 2″ lens at three feet. No song bird is fonder of bathing than the robin



From motion picture film by Norman McClintock

LOUISIANA HERON AND YOUNG AT NEST

Above, Louisiana heron and several nests; below, the bird and one of the nests shown by telephoto. With the telephoto lens one can, without intrusion, be on intimate terms with the home life of the birds. These photographs were made on the preserve of Mr. E. A. McIlhenny, at Avery Island, Louisiana

From motion picture film
by Norman McClintock

LOUISIANA HERON AT CLOSE RANGE

Consecutive sections of a bird film taken with a 12″ telephoto lens. The parent utilizes the time while guarding the nest, in preening her feathers

note that, to produce a 4″ × 5″ still picture on the same basis as I do the 1″ × ¾″ motion picture with this 17″ lens, it would be necessary to use a lens of about 13″ diameter. This comparison will give an idea of how the question of speed is met in producing telephoto lenses for cinematography. Owing to the difficulties described, cinematographers have so far but little used telephoto lenses of a longer focus than eight inches.

Several years ago I realized the possibilities for usefulness of telephoto lenses of long foci when applied to bird work. I therefore secured the two most powerful cinematograph telephotos I could find and I will now confess it was without a full comprehension of the difficulties I had in store for me. But, as "necessity is the mother of invention," the problems were gradually met.

Having worked for many years at bird still photography, I observed that individual song birds would permit me openly to approach them to within a more or less definite distance, which was rather constant. This distance I term the critical distance and it could be determined for each individual bird.

It then occurred to me that if I could work on birds outside their critical distance and still secure photographic images of a satisfactory size, a new, and, as far as I was aware, an unused field would be opened up to me. This reasoning combined with some simple mathematical calculations led to the procuring of the cinematograph telephotos already mentioned.

As a concrete example of this type of bird photography I will say that it is manifestly an impossibility, without the use of a blind, to approach and photograph the average adult robin at a distance of three feet. And yet by employing my seventeen-inch lens and working at a distance of twenty-five feet, which is thoroughly practical, and which is outside the generally accepted robin critical distance, I can secure an image of the same identical size on the film as I would be able to do with the standard two-inch lens at a distance of three feet.

I often have recourse to blinds for bird work and they are many times essential, but I must confess it is a source of still greater pleasure to me to meet song birds in the open and to be able with their full knowledge and consent to secure motion pictures[1] which occasionally depict interesting and characteristic habits.

It will be noted that in what I have written so far the application of the telephoto lens has been confined to comparatively close work. The photographing through the cinematographic telephoto lens of larger animal life at a distance from the camera, often introduces the additional problem of the light rays passing through air strata of different and varying densities, with the consequent fluctuating distortions of the objects. This defect can only be met by selecting a suitable time for making the pictures. The best time for such distant work is in the early morning and the late afternoon, when the heat radiation from the earth is less than it is during the middle of the day.

Telephoto work through great aërial distances, such as distant mountain views, presents a problem that cannot usually be successfully met, except with special tools, which must be intelligently employed. Those who have ever tried to make distant still telephotos know the unsatisfactory flat and foggy negatives that usually result, irrespective of the exposure and development. This objectionable quality of negative is due to the action of violet and ultra-violet rays which are present to an excessive degree between the lens and distant objects. This defect, to a small extent, can be and should be reduced by employing a light shield in front of the telephoto lens for cutting off all extraneous light rays.

Investigations in this subject by such expert scientists as the Belgian worker, M. André Collier, and Dr. C. E. K. Mees, of the Eastman Company, seem to indicate that the suspended particles of water vapor, which are present in the atmosphere, especially near the earth's surface, are transparent for the longer waves of light, which compose the red end of the spectrum. Therefore, as the human vision is more affected by the red end of the spectrum than is the standard photographic emulsion, our vision is not materially affected by the intervening presence of water vapor in a landscape view, unless present to an excessive degree. On the other hand, it is supposed that the passage of even moderate

[1] Of the bird pictures which I have shown at the American Museum of Natural History, one entire reel, as well as parts of other reels, was made in the manner described.

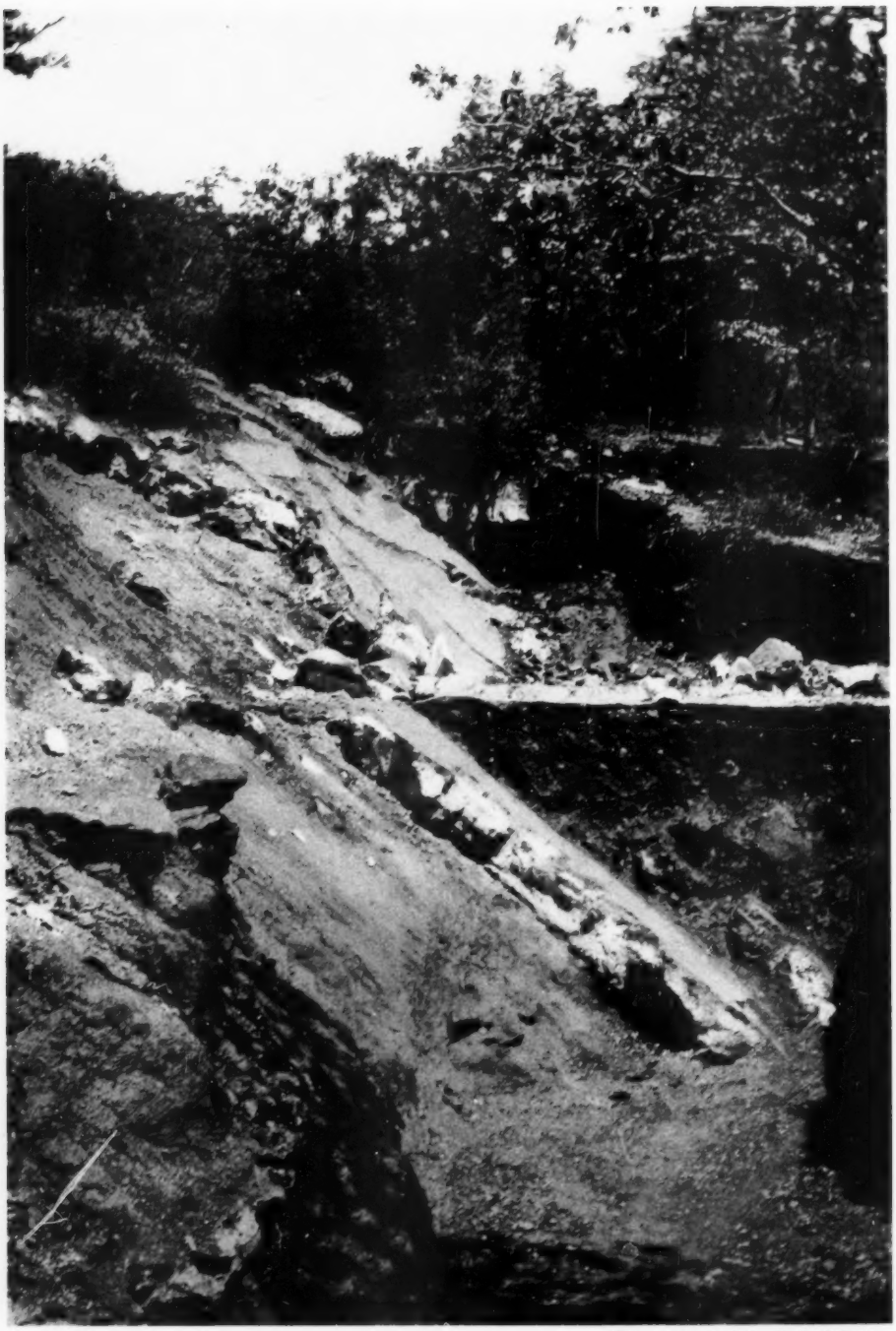
amounts of water vapor offers a turbid medium to the passage of violet and ultra-violet light waves, scattering them and producing upon the photographic emulsion, which is supersensitive to these rays, much the effect that would be seen by viewing a landscape through a sheet of finely ground glass. This scattering effect of water vapor is at a maximum in the ultra-violet rays, to which the human eye is not very sensitive, and decreases toward the red end of the spectrum. In addition to this, when the sky is blue the distant mist reflects this light also and thus makes matters worse for the photographer.

In order to remove these obstacles, due to the presence of ultra-violet light, the special tools to be used are the modern panchromatic film and a deep yellow filter, scientifically selected and adjusted for absorbing all of the harmful ultra-violet rays mentioned. Indeed, so great is the latitude with these new tools that it is possible, if desired, to eliminate the entire appearance of atmosphere in distant views.

The end to be sought for, however, is that in which the resulting picture will as closely as possible represent the view as seen in nature by the eye.

From motion picture film by Norman McClintock

Snowy egret nesting, Avery Island, Louisiana, regular 3″ lens. While the young wear the natal down, the guarding parent spends much time brooding



By courtesy of the United States Geological Survey

OPEN CUT IN HIMALAYA MINE, CALIFORNIA

The pegmatite veins are coarsely developed granites wherein the three constituents of that rock, mica, feldspar, and quartz, are strongly individualized. Pegmatite forms the matrix of the tourmalines which, developed in it in highly colored crystals, form wonderful mineral aggregates with the limpid quartz and opaline feldspars, wherein, more rarely, the lilac kunzite is discovered

By courtesy of the United States Geological Survey

The gem-bearing region in San Diego County, California, possesses to the eye no attractions, unless its sterile slopes and cactus-invaded valleys, in some lights, offer picturesquely desolate vistas. The prospector's zeal, however, has broken through the arid crust of rock, and uncovered a dazzling wealth that has made this inhospitable country a mineral Golconda

Gem Mining in the United States — Tourmaline and Turquoise

By L. P. GRATACAP

IF, as an ancient connoisseur and historian of "Pretious Stones" with quiet confidence affirms, "the climate fittest for the production of stones of excellent beauty are such as do lie nearest the Tropicks," the expectant prospector in our own country, guided by so grave a dictum, might too quickly relinquish his pursuit of these mineral rarities. Nature has not blessed the United States very plenteously with gem stones, but neither has she been too niggardly in bestowing, here and there, in the long ranges of our mineralized belts, very stimulating stores of such treasures. Her discrimination in being more lavish to us in her gifts of rich economic deposits of earths and ores, was commendable. For although gems may have been, as quaint Thomas Nicols pompously assures us, "generated of an humour which containeth in itself purest terrestrial portions," yet the disillusionizing experience of commerce pretty clearly shows them inferior to the more homely coal, clay, metallic oxides, and salts.

As a matter of fact the United States cannot qualify, at present, as a gem producer of any large commercial importance. In only four important regions have rewards for the gem hunter attained for it a somewhat secondary place among the great gem marts of the world. Nevertheless, in the sporadic development of gems, consequent upon the chemico-crystallographic agencies at work in the formation of large crystalline areas of rock, the United States offers a wide and instructive, if not always profitable, field for exploration.

Within a few years a quite astonishing

discovery of a new mineral and a new gem in San Benito County, California, revealed an unsuspected hidden pocket of interesting mineral associations, instructive to the mineralogist, but, alas, delusive to the gem hunter. A new gem was indeed revealed, but it had, so to speak, a most tantalizing brevity of life, disappearing almost as soon as found. The mercantile epigram, current some twenty years ago, that a day's yield of coal or iron, or a week's work in a granite quarry, would exceed the money worth of an entire year's output of precious stones from the United States, might be slightly modified in view of the phenomenal developments in southern California. Yet, allowing to these latter every possible weight, the qualification would turn out to be scarcely more than an academic correction. Even the diamond discoveries in Arkansas have proved to be rather sensational and promissory hints, than practically valid assets.

The important localities of precious stones in the United States, as at present best recognized, are the tourmaline properties of Maine, the tourmaline veins of southern California, the turquoise diggings of Arizona, New Mexico, and Nevada, and the sapphire quarries of Montana. Of course this is doing scant justice to the wide prevalence of a host of lesser gems, which, throughout the crystalline belts, momentarily illuminate with glimpses of color and brilliancy the prosaic work of mining. There are incidental revelations of handsome gems in the granite beds from time to time, which appear only to vanish in a miscellaneous assembly of worthless companions. Among these gems may be mentioned the beryls of North Carolina and elsewhere, sometimes graduating into unmistakable emerald, the topazes of Texas, the opals of the West, the wonderful kunzite of California, and the not infrequent garnets and amethysts everywhere. A painstaking empiricism has also involved—we think rather spuriously—a great number of less truly gemlike minerals within the aristocracy of gems, and they are all well represented in the United States. But they have really effected a purely parasitic association with the invincible precious stones of the world.

The specimens of gem tourmaline, found at Mt. Mica, Maine, ushered the United States upon the gem exchange of the world, since its products rivaled the best tourmalines found anywhere. The discovery, now a well-rehearsed tale, was made by Elijah L. Hamlin and Ezekiel Holmes, both of them enthusiastic mineral hunters, and both boys. They had started upon one of those familiar tours among the hills with hammer and chisel, which so often reward the devotee with little more than the exercise. Young Hamlin picked up a crystal—it was during an autumn snowstorm—which had separated from the roots of a fallen tree, dislodged perhaps from its mineral setting by the intruding roots. A little further investigation brought the overjoyed collector thirty more beautiful crystals. All but one of these were subsequently lost, and then, according to a malicious rumor, reappeared in the Imperial Cabinet at Vienna.

The locality of Mt. Mica, after the announcement of its wonderful contents, was visited by many mineralogists, and upon more disclosures, a mining company with Dr. Augustus Hamlin as its president, was organized in 1881. This company has prosecuted the work of mining the gems ever since, with varying success. There have been taken out from the Mt. Mica mine, and from the neighboring localities of Auburn, Hebron, and Norway, some superb green stones, flawless and delicately dichroic with yellow tints; also some remarkable dark blue crystals exhibiting the familiar zonal colorations from end to end, and with rubellite centers framed in green borders.

The region in which the tourmalines occur is formed of coarse granite veins, piercing mica schist, and these pegmatitic invading masses are banded. The coarser elements, that is the portions in which the quartz, feldspar, and mica attain a larger individual development, encase the gems. The mother vein contracts and then again spreads, as though in its upward flow through the country rock, it had paused, expanding like an arrested stream and continued its penetrating course through constricted openings, while within, slowly crystallizing, the gem tourmalines shaped themselves. The zonal character is revealed in the rude alignment of a feldspar strip against a garnet-bearing ribbon of rock, with a lower granitic underwall. The lithia mica (lepidolite)—so constant an associate of the precious tourmalines both in California and in Madagascar—is blended with common mica (muscovite), and everywhere the vein is most capriciously

provided with the tourmalines. On opening the rock the veins are found to be widely and variously altered by decomposition, resulting from the infiltration of water, with the inevitable change of the feldspar into a soft discolored clay. The tourmalines are uncovered in pockets—usually detached—lying on the clay beneath them. Secondary crystallization has ensued through these interior changes, and in the so-called "live pockets" (a not unreasonable designation when one sees the activity their presence entails among the workers) the quartz crystals are themselves coated with a thin crust of tiny tourmalines, which are absent in the "dead pockets."

At Mt. Apatite, some four miles from the town of Auburn, similar, but differently conditioned, relations occur. The Pulsifer and Keith Mine on the southwest side of the mountain has been worked for gems in a small way for forty years, and in 1907—as Mr. Pulsifer informs me—it was first worked for feldspar, in conjunction with the unintermittent search for the gems. Here the signs which indicate the neighborhood of the gem matter are a lamellar form of the feldspar, albite (cleavelandite) and the lithia mica, embedded in the coarse granite. In June, 1916, Mr. Pulsifer secured at one point, six thousand carats of blue-green tourmaline, and encountered in the vicinity several pockets of the mineral herderite, a beryllium salt, and justly eminent as a mineralogical prize.

A further survey of tourmaline mining in the United States transports us to southern California—a region where tourmalines, kunzite, and the many lithia compounds, flashed their hues and displayed their massive development, not so many years ago, to an amazed and almost incredulous world, repeating, as everyone soon discovered, the mineral phenomena of central Madagascar. The region in California which, some twenty or more years ago, began to yield to explorers these uncommon crystals, lies almost wholly in San Diego County. The localities of Pala, Pala Chief, Mesa Grande, and Ramona practically furnished the largest part of the commercial output of tourmaline, a gem finding one of its best markets in China, whose merchants exult in its richness of color and its impressiveness of size.

In San Diego County there may be seen a series of moderately high mountain ridges, culminating in elevations of over five thousand feet, which overlook the plainlike expanses at their feet. These inauspicious elevations are the lithic pediments of large igneous outflows, and have themselves undergone, under the repeated invasions of later lava-like masses (now recorded in the traversing granite veins), extensive metamorphic alterations. Throughout the invading magmas of granitic lavas the processes of mineralization have generated the extraordinary gem contents of the decomposed hosts, assisted by intensely active chemical agencies, in the boron, hot silica baths, and varying proportions of lithia-bearing waters.

Here, in pockets, in seams, and in druses, a most remarkable retinue of minerals has been crystallized, in some cases showing a rude stratified segregation, the whole transpiring probably, in long continued and successively reinforced periods of digestion and change. Here the gem stones, tourmaline and kunzite have formed, the commercially valuable lithia-containing lepidolite, and amblygonite, with a clustering association of many-colored quartzes, potash and soda feldspars, beryls, garnet, epidote, and micas with later derivatives, and were perhaps preceded by original emanations of sulphides and native metallic sublimates.

A mineral individuality is discoverable in these marvelous belts of mineral profusion, so that the lithia mica with its splashes of radiating red tourmaline, and with amblygonite, prevails in one region, the big diversely colored tourmalines in another, kunzite, in the loveliest shades of gentian and lilac, in still a third, and garnet and topaz in a fourth. Scant justice can be done in words to this prodigality, and while the collectors revel in the abundance of color and species, the crystallographer is no less astonished at the local peculiarities of formal development in the crystals.

The tourmalines and kunzites have, of course, given the region its fame as a gem-producing locality, and the size and color of the former have momentarily eclipsed the claims of all other localities. In the Morgan Gem Collection in the American Museum of Natural History are to be seen the cut rubellite—beautifully zoned gems, with red at one end of the polished cabochon and green at the other, while in a wall case are grouped the colossal crystals of rubellite, inserted in the sides of yellow-white crystal-

lized quartz, and near them the stupendous crystals of kunzite in mimic cliffs of purest rose-lilac.

Up to 1905 the Mesa Grande locality yielded a gross output of $200,000 in gems, in which total the singular cat's-eyes are to be noted, whose refractive phenomenon is caused by thread inclusions, or by symmetrically disposed hollows. The colorless stones (achroits) decline into absolute unimportance by the side of their gorgeous companions, whose extreme length often measures eight inches.

If the reader will stop in the Morgan gem hall and examine the case of kunzite, he will see some of the finest examples of this seductive and quite indescribable gem. It is a gem spodumene with a high percentage of lithia—an element which seems to confer color in an unusual degree upon its compounds—and which, before these discoveries in California, was little more than suspected, although small colored fragments had been found in colorless spodumene. Dr. George F. Kunz—gem expert with Tiffany and Company and associate curator of gems in the American Museum of Natural History—recognized the mineral when the first large crystal from California was shown to him. Later, after a critical examination by Prof. Charles Baskerville, of the College of the City of New York, the newcomer—for new in all legitimate senses it was—was named after Dr. Kunz. A unique pocket yielded five enormous crystals of this paragon of gems, and two of these now astonish the connoisseur in the gem hall of the American Museum.

In its appeal both to scientific and æsthetic interest, the tourmaline justly ranks high among minerals. As a natural salt its composition is difficult to enclose exactly in a formula, since it varies in its chemical constituents, and reflects these variations in its appearance and properties. As a mineral occurrence it presents interesting circumstances of genesis and association; as a gem it is a "chameleon" in its inconstancy, and yet attains the most attractive grades of gem beauty, while in optical properties, in crystallographic development, and in electrical reactions, it offers an inviting field for experiment and study. As a gem its finest developments are found in the clear, limpid, and solid greens of Maine, but in California it is remarkable for its mineral growth and coloring, its variety, size, and combination.

It is worthy of note that the California rubellite greatly surpasses its congener from the tourmaline mines of Madagascar.

A closing note of interest is to be recorded in the occurrence of pink beryl. These delicately tinted crystals have much charm, from peculiarities in their crystallization, but to the gem hunter they appeal by reason of the promise they half fulfill, that they may somewhere, some day, attain the gem quality of the famous morganite (vorobyevite) of Madagascar, a princely gem with which Nature has enriched the mountains of that island. These pink beryls have appeared in San Diego County, associated with yellow, green, and even blue varieties, but they have not yet been found possessing the tone depth and richness of the Madagascar stone.

An observation of interest to be made upon these gem occurrences of tourmaline, wherever they have produced gem material in quantity, is the striking resemblance the geognostic features present in every instance—the coarse granites, the abundant evidence of lithia, the commingled development of the same minerals, some peculiarities of crystallization—as in the beryls—a closely approximated succession in the mineral generation, the prevalence of the soda feldspar (albite), and the very generous association of quartz.

Leaving California, we descend into Arizona, among the turquoise mines. Centuries ago turquoise was mined by the Indian in a part of New Mexico savagely placed amid decomposed and crumbling mountains. Today his excavations tunnel the cliffs, deserted and valueless, and pits two hundred and three hundred feet deep, exhibit a vast removal of waste, where he searched the tufaceous rock for the bits of prized gem. The old channels and galleries of the Aztecs in the Burro Mountains have become filled with detritus now hardened into a refractory mass only penetrable by extended blasting. The stones found in the workings show many shades of color but enclose white centers, and green shades prevail, making poor showing against the robin's-egg-blue, or azure of the higher grades of the gem.

In Mohave County, Arizona, well-organized explorations continue for this valuable mineral, and the present activity, with the incentive of expanding markets, almost bestows upon turquoise mining the leader-

ship among American gem industries. It appears to be a product of alteration, and is invariably symptomatic of igneous intrusions, with consequent decomposition, followed in many fields by a later saturation of the corroded rocks by quartz. This last invasion has cemented the whole complex into rugged refractory strata. The turquoise, exhibiting the widest range of quality, occurs as nuggets and balls, and in veins and seams with interspersed incrustations.

The demand for this gem is not easily satisfied, and the output in 1908 was appraised at $150,000, to which yield Nevada, Colorado, New Mexico, Arizona, and California contributed. Turquoise is not regarded with unstinted admiration by the gem collector; it has too often repaid his confidence with disappointment by its loss of color. Not admitted into the first rank of gems it is classed among the second and even third-class stones, because of this tendency to deterioration. But in its most perfect state the soft blue of the turquoise, rendered precious in fine examples by its durability, rivals the other gems. At any rate it has been cherished by connoisseurs for many centuries, and its popularity today is unmistakable. Dr. Berthold Laufer of the Field Museum, Chicago, says that in the eyes of the Tibetans the turquoise had a sacred character that lifted it above the ordinary category of stones; "to call a turquoise a stone, to the Tibetan, is offensive, and his indignant remonstrance *DI YA RE, DO MA RE,* informs the astonished visitor that it is a turquoise and not a stone."

Mohave County in Arizona has monopolized the turquoise product of the state. One approaches a group of hills which are the more or less isolated elevations distinguishing the west side of the Cerbat Range and included in the general geographic designation of Mineral Park. The lithological conditions embrace a preëxistent Pre-Cambrian rock, invaded by later granites and porphyries. The gem stones are found in these intrusions, which, weathered and eroded, assume a high relief, the rigidity of outline being maintained by saturation of the mass by quartz.

Processes of alteration succeeding one another in more or less defined order, have been accompanied by circulating solutions depositing or forming turquoise. Dark stains of iron oxide blotch the seams of quartz or turquoise, and the variegation of color is heightened by copper stains of blue and green smearing the kaolin with vivid or dull, faded streaks, like the droppings from a paint brush. The turquoise is found irregularly developed in veinlets of rock crevices, with rarely a tendency to form a nuggety mixture, from which sizeable gems may be extracted.

In almost all the workings, here and elsewhere, the turquoise is a secondary occurrence, consequent upon the initial decomposition of the matrix, and the later entrance into the jointed mass of phosphate solutions, with the final "setting" of the gem itself in favorable nuclei of concentration and along narrow ribbons of interstitial quartz. In some workings veins six to eight inches in thickness are encountered, while elsewhere the turquoise penetrates its host in threads, or appears in patches, rather haphazardly yielding pure turquoise, semi-turquoise, and green soft kaolin. The finest quality of stone is not common, and the sorting—which is very exhaustively done—separates out the greenish pale varieties and the soft turquoise, both of which are worthless for commercial purposes.

A picturesque situation has been developed by the Arizona Turquoise Company. This company has attacked the steep slope of Ithica Peak, one of the Mineral Park summits, and entered the mountain-side by an open cut. The operation involves the formation of a series of terraces, each twelve to fifteen feet high. Drill holes are sunk and great masses of rock dislodged by blasting. Hundreds of tons of rock are thus brought under the sledge, and from the broken and crushed fragments the turquoise is picked out. There is an eager scrutiny for the fine-colored stones, which are afterward more tenderly extracted with smaller implements, and some solicitude. The stimulated interest in turquoise urgently requires for its satisfaction new developments of the pure blue and permanent mineral.

THE JACK RABBIT, SANTA CLARA VALLEY, CALIFORNIA

The "rabbit drive" no longer occurs in California. Irrigation and the resulting increased occupation and cultivation of the land have effectually reduced the ranks of the previous hordes in the state and driven the remnant to a restricted range among the foothills. The largest rabbit drive known to have taken place in California was that of 1896 at Fresno, when eight thousand people participated and twenty thousand rabbits were killed

The Jack Rabbit in California

By MARY CYNTHIA DICKERSON

Illustrations from photographs by the Author

This brief study of the developing jack rabbit was written in California, at Stanford University, from notes accumulated during the daily care and observation of a pair of young rabbits, from the time of their birth, February 26, until they were three months old. During the first six weeks of this period they took kindly to a diet of cow's milk administered through a small opening in a pipette rubber attached to a small vial, as I had found by previous experience other young mammals will do—skunks, woodchucks, cottontail rabbits. As far as known, nothing has been published heretofore on this development of the jack rabbit. The interest lies especially in observations made on their developing instincts—namely, that certain actions, such as washing the face, are not learned by imitation of the parent or through experience, but are instinctive from the moment of birth; that a generalized fear instinct arises soon after birth and becomes specific through experience, a valuable safeguard for the race in its definite environment; and that the play instinct develops those activities—digging, listening, leaping, running, nest building—which are to prove necessary for the life of the adult.—THE AUTHOR.

THE snow was still on the mountains of the Coast Range but the foothills were green, buttercups and mustard were beginning to make the fields yellow, and an occasional poppy of the hosts to appear later was showing along the roadside or in the oat field—in other words, it was February in the Santa Clara Valley.

I had been tramping the foothills, where the most conspicuous evidence of life is furnished by the jack rabbit. Now and again the gray forms had started up from the shelter of rocks or small bushes, or sometimes had appeared suddenly as if materialized from empty air, to speed away with incredible swiftness.

Now I was at my desk in the University laboratory, my back to the window with its view of mountains and foothills. Suddenly there was shouting, and a rush of feet on the campus outside. Three laborers were chasing and stoning a jack rabbit. Soon they had it cornered in an angle of the buildings and were about to use a club. It was the

work of but an instant to reach the door and by a bribe change the intention of the man with the club. So the rabbit was caught unhurt (not without the expense of numerous long scratches on the hands and arms of the captor), and was soon in a rabbit house improvised from a packing box. She did not give up her freedom without further struggle, but between the periods of bewildering activity and thunder of hind feet on the wood of the box, she looked out from her temporary prison with large, gentle eyes.

The next morning (February 26), on entering the laboratory, I chanced to observe a small brown oval patch in a corner of the room. Bending down over it, I saw two large, luminous eyes gazing mildly at me. It was a baby jack rabbit, so small that it could be held, I found, and partly covered in one hand. Diligent search of the room disclosed one other baby in the farthest corner under the radiator—a family of two. Both together could be held securely on one palm and they showed little fear and no desire to leave the spot.

The California jack rabbit (*Lepus californicus* Gray) is born in an unusually advanced condition. The young rabbit is covered with fur, his white teeth are cut, and his eyes are wide open. His coat is brown with accents of yellow and black, much richer in coloring than the grayish fur of his mother; and he is labeled a very young baby jack rabbit by a light gray area which surrounds his mouth and his brown wiggling nose—like a round bib tucked above his chin instead of below.

On comparison he scarcely seems the son of his mother. His ears are not half the length of his head, whereas hers exceed the head in length by two inches. Also his muzzle is short and broad instead of long and pointed like hers—in fact, his face is ludicrously flat below the eyes as though he were really as soft and plastic as he looks and had received a gentle but convincing blow on the nose. And thirdly, his short, stocky legs would certainly classify him as the offspring of some other rabbit than a jack.

But these are all items of his immaturity. By the tenth day the ears and legs begin to lengthen out of proportion to the increase in growth elsewhere, and his muzzle also begins to lengthen and narrow. The changes in the shape of the muzzle and in the length of the legs are gradual, but the growth of the ears from this time on is astonishingly rapid. At the fifteenth day they equal the head in length; soon they outstrip it, until at the close of the fourth week they are four inches long and at the end of the fifth week measure four and a half inches, whereas the head is then only two and three fourths inches in length. It is amusing to see Baby Jack take advantage of this increased length of his ears to haul them down and wash them conveniently in his mouth—he has the instinct to wash his face from the first morning of his life.

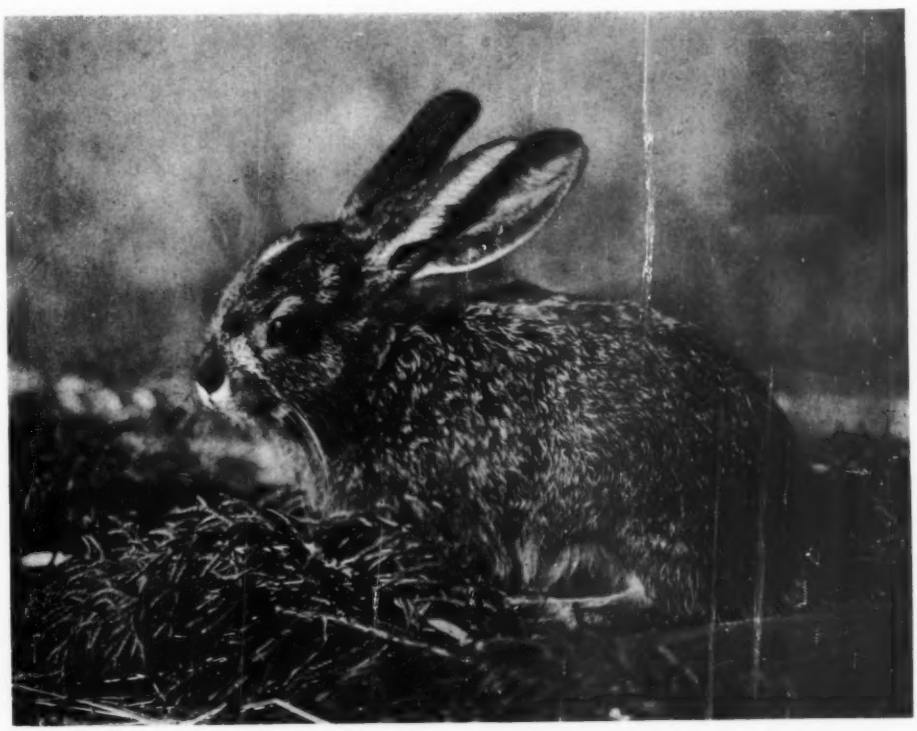
During the first days jack rabbits have a generalized sense of fear, squatting with lowered ears at any sound or movement; also they have a bravado not possessed later, turning and jumping at the enemy in pugilistic fashion while expostulating in a harsh, low-pitched voice. Later their fear becomes very definite and vivid, yielding not a jot to months of care and captivity.

One of the most conspicuous signs of a jack rabbit's babyhood lies in his inability to gauge perpendicular distances. For the first few days his instinct keeps him pretty closely to the ground nest, otherwise he would try to walk down hill as though it were level or would unwittingly walk off any rock or hillock and so might get many a tumble. It is not until the third day that he begins to be cognizant of the ups and downs of his world. His development is rapid, however, and twenty-four hours later he stops and studies every situation.

On the fourth day he begins digging, and from this time until he is five weeks old spends much time in this employment. Serious-eyed and absorbed he works very hard—like all young mammals he is "dead in earnest."

Jack rabbits have the play instinct from the first day. In this case observed, play activity increased steadily from the fourth day to a maximum at the close of two weeks, then continued, apparently without change, except as influenced by increasing muscular strength. Playing rabbits are intensely alert. When facing away from each other, suddenly, with what seems simultaneous leaps a foot or more in air, they are turned about touching noses. They bound away in devious curving and zigzag courses, moving with indescribable lightness and stopping with startling abruptness. One jumps at the other "pell-mell," he in turn shoots straight up into the air, dropping to a listening position with long ears held far forward, very

A very young baby jack rabbit. He scarcely seems the son of his mother, for his fur is rich brown in color instead of gray, his muzzle is short and broad instead of long and pointed, his legs are stocky, and his ears are very short. He is not yet so afraid as his mother and will face about and jump bravely at any enemy that appears, while scolding in a harsh, low-pitched voice



The ears of a jack rabbit two weeks old have grown to be as long as his head, but from this time on they increase in length at an astonishingly rapid rate. He has the instinct to wash his face from the first morning of his life; on the third day he begins to gauge perpendicular distances; the digging instinct develops on the fourth day

deer-like. Again, they take to following the leader: one jumps over a stone, the other follows; the first leaps a chasm two feet wide, the second is at his heels; they crouch in the shadow of a stone, then dash out into the light capering, then peer out from the shadow again where they remain, momentarily interested in washing each other's faces. Soon they are playing boisterously again, one bounding into air without any preliminary hint of such an intention, the other shaking his head until his long cartilaginous ears snap together. Finally one of them sees something that stimulates his curiosity. He watches eagerly, his ears straight forward and widely opened. He progresses a little, he drops one ear, he moves slightly to the right, to the left, he stretches slowly forward, investigation written plainly in eyes, ears and tense muscles. Ah! it's only a shadow after all and Bunny Jack races away, lowering his tail so that it is like a little black streak between his flying hind legs.

A very serious and determined young rabbit (four weeks old), but ready for play at any moment. Jack rabbits have the play instinct from the first day, but play activity increases from the fourth day to a maximum at the close of two weeks, continuing unchanged thereafter except as influenced by increased muscular strength

The most surprising thing about young jack rabbits in the light of the fact that they are so highly developed when born, is their continued dependence on a milk diet as the weeks pass. On March 2 (sixth day), they showed the first recognition of the possession of teeth by chewing at the nest material. When two weeks old (March 10), they gained their first interest in grass, sniffing at it with noses a-wiggle and little red tongues thrust out at right or left, but refusing to eat more than one or two of the grass ribbons. The three weeks' limit was reached (March 17), four weeks were gone (March 24), five weeks (March 31), and the situation seemed astounding. Six weeks (April 7), at last they showed willingness to eat clover and grass. During the seventh week they were weaned from their improvised "bottle"—most unwillingly on their part—and with the change in diet became increasingly wild.

This long period of dependence on the mother jack rabbit is an interesting fact for the gardener as well as for the naturalist. It is likely that in this relatively northern part of California the jack rabbit breeds only three or four times a season, the months of October, November, December, and January constituting a definite winter season. Therefore the best time for reducing the ranks of these rabbits is during the winter months, before March—provided the ranks ever again need reducing.

For in California rabbits for the most part no longer devastate the crops. This is owing to a constant

warfare against them since 1875, and also because of the continually greater occupation and cultivation of the country. The rabbit drive, one of the unique and picturesque features of early life in the West, no longer occurs in California. This is certainly well; for those days of special holiday, of closed schools, of general rejoicings and barbecues, when men, women, and children gathered from miles about, driving the rabbits into a corral, where as many of the people present as desired competed in the work of clubbing the helpless, screaming creatures to silence and death—those days must have been indelible lessons in cruelty. We remember that the number of rabbits killed in a single drive ranged from a few hundreds to twenty thousand; that in 1888, rabbit driving having reached its height, newspapers estimated that 40,000 rabbits had been killed in Fresno County during the spring, and 70,000 in Kern and Tulare counties, respectively; that the total number of drives in California up to 1898 was more than two hundred, with half a million rabbits destroyed.

Today, only twenty years after the largest rabbit drive California ever knew—1896, Fresno, 8000 people, 20,000 rabbits killed—the custom is becoming a forgotten thing of the past. Those parts of California where the greater number of drives took place have changed in aspect. San Joaquin County, for instance, from being the leading county in the production of wheat, barley, rye, and hay, with fewer than two thousand farms (a third of these containing more than five hundred acres each), has become noted for its irrigation projects and its success in intensive farming. The farms now number several thousand and are relatively small. Grain fields have given place today to orchards and vineyards, market gardens and dairies.

And the jack rabbit? He had most picturesquely held sway over the fertile valleys and plains as well as over the drier foothills before the arrival of the settlers from the East. Breeding rapidly, and each individual having a life probably eight or nine years long, the hosts had grown strong, maintaining their numbers despite the inroads of natural enemies and disease, despite the attacks of the Indian, whose greatest pride was his blanket woven of twisted strips of rabbit fur. But, like the Indian, the jack rabbit has been driven from his dominion. The great army of the fleet-footed has been routed and the remnants forced back to the strongholds of infertile foothills. He is now becoming only an unnoticed part of the state's wild life, of its small game, no longer important enough to carry a bounty on each pair of the long ears.

So as we tramp the foothills and see an occasional jack bound into air and race away, its lithe body superbly built for grace and speed, we forget that it has known anything but the relatively peaceful life it led in past ages and now leads among the rocks and dry slopes of the foothills. Here the adult today yields to few enemies outside of the coyote. Its speed distances any dog, and the slow badger has no chance in the chase. It is likely that many young rabbits succumb to these enemies as well as to skunks and weasels, to say nothing of the barn owl, the western red-tailed hawk and the marsh hawk. But other young rabbits, those who survive, reach maturity equipped with the fleetness and with the great wariness of their ancestors.

Museum Notes

SINCE the last issue of the JOURNAL, the following persons have become members of the Museum:

Life Members, MRS. WARNER M. VAN NORDEN, and MESSRS. AMOS P. BROWN, GEORGE BULLOCK, HENRY C. DRAYTON, COLEMAN DU PONT, OTTO M. EIDLITZ, CHAS. H. LOUIS, DWIGHT W. MORROW, A. PERRY OSBORN, H. FAIRFIELD OSBORN, JR., WALTER C. WITHERBEE, and F. W. WOOLWORTH.

Sustaining Members, MRS. M. GOLDFRANK, MRS. PIERPONT MORGAN, and MRS. FRIDA ZINSSER.

Annual Members, MRS. A. H. ALKER, MRS. E. FARRAR BATESON, MRS. FRANKLIN Q. BROWN, MRS. JAMES BYRNE, MRS. GILBERT COLGATE, MRS. F. DALZIEL, MRS. MABEL LANGENBERGER-JONES, MRS. J. L. MOTT, MRS. JAMES BRONSON REYNOLDS, MRS. GEORGE S. RUNK, MRS. VICTOR SORCHAN, MRS. EDW. R. STETTINIUS, MRS. JOHN N. TONNELÉ, MRS. F. A. VANDERLIP, MRS. D. B. VAN EMBURGH, MRS. VANDERBILT WEBB, MRS. ELI WHITNEY, MRS. A. M. WITTENBERG, and MISS E. H. WISNER, the HON. WILLIAM MCADOO, and the HON. JAMES W. WADSWORTH, JR., DR. MILLER REESE HUTCHISON, DR. MORTON R. PECK, DR. HERMAN SCHWARZ, and MESSRS. MORTIMER C. ADLER, JOHN G. AGAR, PERCY S. ALDEN, DARWIN R. ALDRIDGE, JAMES W. ALKER, WM. HALL ALLEN, CHARLES LANIER APPLETON, GEORGE T. BROKAW, EDWIN BURHORN, EVERLY M. DAVIS, FRANK G. DOELGER, EDGAR M. DOUGHTY, GEO. SIMPSON EDDY, WILLIAM L. HERNSTADT, SAM A. LEWISOHN, NORVIN R. LINDHEIM, WILLIAM J. MILLARD, G. M. P. MURPHY, SAMUEL RAISLER, CHARLES F. SWAN, JOHN RUSSELL TABER, SAMUEL A. THOMPSON, F. T. VAN BEUREN, JR., MARTIN VOGEL, MAX WATERMAN, ANDREW GRAY WEEKS, J. S. WILEY, LOUIS WILEY, WILLIAM H. WILLIAMS, BARKLEY WYCKOFF, EDWARD GUILD WYCKOFF, CHARLES ZIMMERMANN, and MR. GEORGE L. JEWETT in memoriam.

THE chemical preparedness exhibit which was arranged at the American Museum under the auspices of the American Chemical Society, the Electrochemical Society, the Society of Chemical Industry, the American Museum of Natural History, and the Museum of the Peaceful Arts, in honor of the meetings of the American Association for the Advancement of Science, will be continued until February 1. There are on display specimens of seventy-four of the eighty-five elements, the largest number ever grouped in this country. One group of nineteen contains all the elements found in nature in uncombined state. Through the courtesy of Lady Ramsay there is exhibited the original group of elements—helium, xenon, kripton, and neon—discovered by the late Sir William Ramsay. There are also relics from the work of Joseph Priestley, the discoverer of oxygen. The progress made by this country in industrial chemistry since the beginning of the European war is illustrated by cases of coal tar products including dyes and medicinal preparations. Products of the electrical furnace and those obtained by the fixation of atmospheric nitrogen are also exhibited.

With the chemical exhibit is a case prepared by the department of public health of the American Museum, showing certain phases of the life and works of Louis Pasteur. Pasteur was by training a chemist and his contributions to chemistry were valuable. He found time, however, for other and varied activities; in his younger days he did portrait painting that has been saved to us; when the silk industry was on the verge of destruction because of the spread of disease among the silkworms, he came forward with a cure; and it was he who first showed that fermentation was due to microörganisms of the air. His greatest service to the world was the demonstration of the use of vaccines in diseases of man and animals, particularly in cases of anthrax, rabies, and fowl cholera.

AMONG those who attended the meetings of the vertebrate section of the Palæontological Society held at the American Museum, December 28–29, were Dr. J. C. Merriam, of the University of California; Dr. E. H. Sellards, state geologist of Florida; Dr. O. P. Hay and Mr. C. W. Gilmore, of the National Museum; Professor R. S. Lull, of Yale University; Dr. W. J. Sinclair, of Princeton; and Dr. F. B. Loomis, of Amherst.

MR. ALESSANDRO FABBRI exhibited at the annual meeting of the New York Zoölogical

Society on January 9, a remarkable series of motion pictures made last summer at Bar Harbor. An explanation of the film was given by Mr. Roy W. Miner. Through the aid of the most improved apparatus and a carefully developed technique, Mr. Fabbri has succeeded in reproducing on the screen on a greatly magnified scale many small and microscopic animals. Various species of Protozoa, including the *Amœba*, and many small Crustacea like *Cyclops*, *Evadne*, *Prodon*, and *Caprella*, were among the forms shown. The presentation of the last was especially interesting, as not only was the entire animal shown, but also, by further enlargement, details of the head and internal structure, and the circulation of the blood. The beating of the heart of an embryo fish within the egg was brought out especially well. The fresh-water *Hydra* of stagnant pools, which is only about one thirty-second of an inch in length, was magnified upon the screen about six thousand diameters; certain species of the most delicate of marine hydroids were magnified to a like scale. Mr. Fabbri's work opens new vistas to the teachers of zoölogy who can introduce such pictures in their classes, and will be of great value to those who are engaged in research on the anatomy and habits of such minute forms.

MR. N. C. NELSON returned late in December from a field trip which included a systematic survey of the glazed pottery area of the Southwest, and also an examination of caves and rock shelters in Kentucky. In the Southwest the territory reconnoitered comprised a broad belt from Aztec to Albuquerque on the Rio Grande, and thence southwest to St. Johns and Springerville in Arizona. During this journey, which involved traveling by wagon, in the saddle, and on foot, over more than two thousand miles, and occupied about four months, about four hundred ruins were examined and the more important were roughly mapped, described, and photographed. Wherever ash heaps occurred, stops were made to obtain the stratigraphy of the deposit.

In Kentucky examination was made of a series of caves and rock shelters along the Kentucky River, and of a larger series along Green River near Mammoth Cave. Several sites were tried out by excavation. Few of these yielded results of importance, save a small rock shelter opposite Boardcut Island, and Mammoth Cave itself. In the entrance to the latter was found a partly buried floor deposit of refuse belonging to a hunting period of culture antedating the introduction of fine polished stone implements and pottery, while in the former were found traces of refuse and a stone cist burial containing fragments of pottery, all clearly belonging to a relatively late period of Indian occupancy of the middle Mississippi region.

THE opening session of the sixty-ninth meeting of the American Association for the Advancement of Science was held in the auditorium of the American Museum of Natural History on the evening of December 26. The retiring president, Dr. William Wallace Campbell, director of Lick Observatory, gave an address, "The Nebulæ." Following the address, the Honorary Committee which had been appointed by Henry Fairfield Osborn, president of the American Museum, entertained the visiting scientists at a reception in the new hall of the age of man. Mr. Charles R. Knight's mural painting, "The Age of Reindeer and Mammoths," was unveiled at this time. The orchestral program, under direction of Nahan Franko, included the whole range of nature music from Handel to Strauss.

AT a recent meeting of the trustees of the American Museum a special grant was voted to the 312 officers and employees of the institution, in view of increased demands made upon them and in consideration of the advanced cost of living. The grant, which equaled ten per cent of the salaries of 1916, was largely provided through personal subscriptions by the trustees.

MR. BARRINGTON MOORE has been appointed associate curator in the department of woods and forestry. Mr. Moore is a graduate of the School of Forestry, Yale University. In 1908–1909 he studied representative forest regions in Germany, France, India, Japan, and the Philippines. From 1909–1914 he was in the Forest Service of the United States, where he had wide experience in field problems and editorial work. Since 1914, when he left the government service, he has devoted himself to research work in silvics and silviculture. He is the author of numerous papers on forestry problems.

AMONG the specimens brought back by Mr. Barnum Brown from his expedition to the Red Deer River, Alberta, in 1915, were two petrified tree trunks, finely preserved and nearly complete. One of these, forty-five feet in length, two and one half feet wide at the butt, and tapering to a slender tip, has been placed on exhibition in the dinosaur hall of the Museum. These tree trunks are from the Belly River formation of Cretaceous age, and were associated with skeletons of dinosaurs. Together with various leaves and other plant remains found in the same beds, they serve to illustrate the kinds of vegetation that prevailed where these dinosaurs lived. The trunk now on exhibition is not that of a tree which grew tall and spindling in a dense forest, but is the type that would grow in an open glade, branching strongly all the way up. When the specimen was unearthed, the branches were all attached, but could not be preserved as they were completely turned to lignite. An interesting circumstance in the preservation of these petrified tree trunks is that the outer layer, above and below, is converted into lignite (carbonized), and the inside of the trunk is partly converted into agate (silicified), the cells of the wood being filled with siliceous deposit, while their framework is still preserved in lignite. Some of the trunks are round, but they are usually flattened, partly as a result of compression. The lignite varies in thickness over different parts of the tree, but if compression is disregarded, the difference in vertical and horizontal diameters shows a conversion of approximately four inches of wood to one inch of lignite. Some of this lignite has been preserved on the trunk now on exhibition, although it was not practicable to preserve the entire coating.

DR. EDGAR ALEXANDER MEARNS, who died in Washington, D. C., near the close of the year 1916, was one of the first of the many men of science who have participated in the work of the American Museum. He was born at Highland Falls, N. Y., September 11, 1856, studied medicine at Columbia University, and in 1883 entered the army with the grade of First Lieutenant Assistant Surgeon. At the time of his death he held the rank of Lieutenant Colonel, Medical Corps. His greatest military service was during the Spanish-American War, when he served as Brigade Major in Cuba and later organized the hospital camp at Chattanooga.

His connection with the American Museum began in 1883, when he donated a series of skins and eggs of North American and European birds, the former to remain unmounted as the basis of a study collection. At this time he was engaged to identify, label, and catalogue the collection of European birds, then larger than that of the North American birds. His first comprehensive paper, on birds of the Hudson Highlands, published in 1878, was based on material found about his home at Highland Falls; from that time onward, wherever he chanced to be, he found scientific work to do. His appointment as surgeon to the Mexican Boundary Commission of 1892–1894, resulted in his publishing *Mammals of the Mexican Boundary of the United States*, and while stationed in the Philippines, in spite of poor health, he made important ornithological and botanical collections. He was a member of the Roosevelt African expedition in 1909, where his enthusiastic work as a collector won for him from the natives the title, "The Man Who Never Sleeps." Colonel Roosevelt states that he was by far the best shot of the party. On this expedition he secured large and important collections of birds and mammals, and of botanical material. He also accompanied Mr. Childs Frick to Africa, where again he made extensive collections of birds and small mammals. He was emphatically a field naturalist. Although his published papers number more than a hundred, they were largely based upon material personally collected. At the time of his death, he was engaged in the study of the large African collections he had brought together.

For his many services to the American Museum he was elected a Patron in 1890. He was a prominent member of the Linnæan Society of New York, one of the founders of the American Ornithologists' Union, and of the National Geographic Society. In his early years Dr. Mearns was one of the group of young, enthusiastic, and energetic naturalists which included Merriam and Fisher, men whose work was not only important in itself, but did much to stimulate others to undertake zoölogical work. His death is a decided loss to science. Ever kindly and helpful, never a harsh critic, and always ready to aid with word or act, he will be sadly missed.

THE department of anthropology has recently received from Mrs. E. H. Harriman a brown sable parka from Alaska, and by gift of Justice Nathan Bijur a fine moosehide war shirt from the Tlingit of Alaska. The department has purchased from C. O. Sachs a number of specimens of Indian material, relics of the battle of Sand Creek in 1864, and of the famous chiefs Gaul, Rain-in-the-face, Spotted Tail, and White Antelope.

THE Museum has recently received as a gift from the Hon. Francis B. Harrison, of Manila, the skin and skull of a timarau from the Philippine Islands. Other recent gifts are five hundred bird skins collected in Ecuador by Mr. William B. Richardson; and birds and the skeletons of a giraffe and a kangaroo presented by the New York Zoölogical Society.

MRS. PAUL MORTON has made gifts to the Museum of baskets from the Northwest, a valuable Navajo blanket, and a bronze statuette, "The Moqui's Prayer for Rain," by H. A. MacNeal. This last represents one of the participants in the snake dance speeding away after the ceremony, bearing in his hands numerous snakes which he is to set free in the open country.

DR. MALCOLM A. SMITH, of Bangkok, Siam, has made a unique and valuable addition to the Museum's herpetological resources in the gift of twenty-two snakes, four burrowing salamanders, and sixteen frogs, all from Siam. Several of the specimens are new to the Museum collection as to species, and some as to genus. Mr. Mahoto Nishimura has presented thirty-six specimens from Manchuria, representing thirteen species new to the collections.

MR. LEO E. MILLER has returned to the Museum after two years spent as leader of an expedition to South America. He and his associate, Mr. Howarth S. Boyle, left October 21, 1914, for Puerto Colombia. From this point they went up the Magdalena River to Puerto Berrio, and thence overland to the highlands of Antioquia, where they spent approximately five months. One excursion, an exploration of the Paramillo region, has already been described in the JOURNAL—November, 1915. Other excursions were to the Atrato River drainage on the west coast of Colombia, and to the Lower Cauca River where, at Puerto Valdavia, large collections were made.

On completing the work in Colombia, the party went to Panama, crossed to the Pacific side, and took a steamer to Peru. Landing at Mollendo, they proceeded by train to Lake Titicaca, which they crossed by steamer, and went on to La Paz for a brief stay. Headquarters for a number of months were made at Cochabamba. From this point excursions were undertaken to the Beni district; large collections were made on the Chimoré and Chaparé rivers. The explorers worked for a month at the Mission among the Uracare Indians. The high country between Cochabamba and the Beni was also explored. The men next journeyed to Sucre by way of the Santa Cruz trail, and explored the country about the Upper Pilcomayo River, after which they proceeded overland to the Argentine Republic, covering the more than three hundred miles on muleback. This is all high arid country where the temperature varies one hundred degrees Fahrenheit every twenty-four hours.

About nine months were spent in the Argentine, in which time many of the northern provinces of the country were visited. Excursions were undertaken from the high Andean peaks in the west to the sweltering *chaco* of the east. The desert regions of Santiago del Estero were also visited. The last work was done in the lake region near San Juan, where large collections of waterfowl were made. Altogether the expedition, during its two years spent in the field, collected between eight thousand and nine thousand birds, about fifteen hundred mammals, made hundreds of photographs, and recorded a number of volumes of data concerning the life histories of animals, types of country, faunal zones, and people.

A SPECIAL exhibition of the motion picture film entitled "How Life Begins" was given in the American Museum auditorium on Saturday morning, January 20, for the teachers of the public schools of Greater New York. The pictures were made by Mr. George E. Stone in collaboration with Dr. J. A. Long, of the University of California, and were shown through the courtesy of the Exhibitors' Booking Agency of New York. They illustrate the story of how plants and animals come into existence. The film consists of the proper combination of actual

photographs of the essential stages in the development of plants and animals, and of carefully labeled diagrams, thus making a complex subject remarkably clear. Following this film there was exhibited another showing the growth of the house fly and its relation to disease.

MR. H. E. ANTHONY will spend the spring months in Cuba, in an effort to secure fossil mammal material for comparison with the specimens recently brought back from Porto Rico. The unexpected discovery of a rather extensive fossil mammalian fauna in Porto Rico points suggestively to the possibility of similar faunas on the adjacent islands, and of important results that might come from correlating the island faunas. It is probable that most of the work in Cuba will be done on the eastern end of the island.

MISS ANN E. THOMAS represented the American Museum of Natural History at the meeting of the New York State Science Teachers' Association at Syracuse, December 27–29. She addressed the biology section on the coöperation that exists between the American Museum and the public schools of New York City in the teaching of natural science.

UNDER the terms of the will of James Gaunt, an annual member of the American Museum of Natural History, the institution is designated as residuary legatee of one half of his estate.

DURING the session of the American Association for the Advancement of Science recently held in New York City, the meetings of the Section of Anthropology and Psychology convened at the American Museum, also those of the American Anthropological Association, the American Folk-Lore Society, the Vertebrate Section of the Palæontological Society, and the Entomological Society. On December 27, Professor T. D. A. Cockerell, retiring president of the Entomological Society of America, gave an address at the Museum on "Fossil Insects." On December 28, Dr. A. A. Noyes, of the Massachusetts Institute of Technology, addressed a meeting of the American Chemical Association in the auditorium of the Museum on "Nitrogen and Preparedness." Following this address a reception was held in the hall of the age of man by the various chemical societies represented at the meetings. On December 29, Professor Frederic P. Gay gave an address on "Specialization and Research in the Medical Sciences" before the Section of Physiology and Experimental Medicine and the Society of American Bacteriologists. There was also held a symposium on cancer and its control.

DURING January Dr. Robert H. Lowie gave four lectures on ethnology at the Museum. The object of the course was to define culture. The subjects considered at the successive lectures were "Culture and Psychology," "Culture and Race," "Culture and Environment," and "Determinants of Culture."

THE American Scenic and Historic Preservation Society, jointly with the American Museum of Natural History, on January 10, held exercises signalizing the establishment of the National Park Service of the United States. The speaker of the evening was the Honorable Robert Sterling Yard, of the National Park Service, Department of the Interior, who gave an illustrated address on our national parks and national monuments.

THE supervisors of the national parks of the United States, who had been called from the West for a conference in Washington, visited New York City January 9 and 10. They were entertained at luncheon at the American Museum of Natural History, by Professor Henry Fairfield Osborn, January 10. Following the luncheon, they made a tour of the Museum, paying particular attention to the habitat groups, the halls of vertebrate palæontology, and the hall of forestry. Arrangements were made for securing from the supervisors a series of tree portraits representative of the national parks. Those present were Major Amos Alfred Fries, Yellowstone Park; Mr. Walter Fry, Sequoia and General Grant parks; Mr. George Estyn Goodwin, Crater Lake Park; Mr. Washington B. Lewis, Yosemite Park; Mr. S. F. Ralston, Glacier Park; Mr. Thomas Rickner, Mesa Verde Park; Mr. L. Claude Way, Estes Park; and Mr. W. A. Welch, engineer of the Palisades Interstate Park Commission.